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MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. XIII. SALT-RANGE FOSSILS,

by **WILLIAM WAAGEN, Ph.D., F.G.S.,**
Professor of Mineralogy and Geology at the I. R. German Polytechnic University of Prag.

I. PRODUCTUS-LIMESTONE FOSSILS:

5. BRYOZOA—ANNELIDA—ECHINODERMATA.

WITH PLATES LXXXVII—XCVI.

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Ser. XIII.

SALT-RANGE FOSSILS.

Vol. I.

PRODUCTUS LIMESTONE FOSSILS.

By **WILLIAM WAAGEN, Ph.D., F.G.S.,**

Ober Bergrath, Professor of Mineralogy and Geology at the I. R. German Polytechnic University of Prag.

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PREFACE.

In finishing the last part of the extensive volume now entirely before the public, the first duty that devolves on me is to express publicly my most sincere thanks to all those who have contributed in any way to the completion of the work.

Among these my greatest thanks are due to Mr. H. B. Medlicott, Director of the Geological Survey of India, who was mainly influential in originating and in sustaining the work. Upon him too fell the task of correcting all the proofs, seeing them through the Press, and editing the whole. I am glad to be able to express this gratitude to him publicly, just at the time when he is about to retire from his service in India. The volume now completed, and the numerous other volumes of the Palæontologia Indica published since 1876, show how earnestly he endeavoured to make his Directorship as fruitful as possible to the Geological Survey of India.

Whilst Mr. Medlicott had a principal influence in the publication of this volume, there were several others who had more or less influence on its contents. Among these were two who, in the meantime, have gone away from among us, Thomas Davidson and Prof. King of Galway.

Who could ever have been engaged on the description of Brachiopoda without coming into personal relations with Mr. Davidson? and who could have had that experience without being struck with the extreme amiability of that learned author. Notwithstanding the great amount of work that he always had in hand, yet he invariably found time to answer all questions addressed to him, to write long and most instructive letters, to give long extracts from books which were not available to his correspondents, with the fullest advice whenever he could. Thus, there is a universal feeling of gratitude towards him among scientific workers by whom his death has been felt most keenly as a severe loss. It was Mr. Davidson who brought about a long correspondence between Prof. King and myself.

Prof. King, it cannot be doubted, was one of the most eminent Palæontologists England ever possessed, and it must be a permanent regret that his palæontological publications were, besides his classical work on the Permian fossils, so limited in number. His letters, addressed to me regarding some difficult cases I had to treat of in the class of the Brachiopoda, were of the utmost value and importance, and I am proud to be able to quote his name among those who have materially helped me in the execution of the present work. His death also has been felt as a severe loss.

Others who helped me in many ways were mentioned in the introduction to this work, but who also are now no longer among the living—Joachim Barrande and Geheimrath v. Abich. Both were most intimate friends of mine, and it is with the utmost regret that I mention them here as passed away before they could see the end of their own fundamental works.

To the list, given in the introduction (page 5), of men of science who have contributed in many ways more or less materially towards the execution of the present work, must now be added the following :—

General Intendant Hofrath v. Hauer of Vienna.
Prof. A. Tritsch of Prague.
Geheimrath Geinitz of Dresden.
Hofrath Liebe of Gera.
Geheimrath Beyrich } of Berlin.
Prof. Dames }
Prof. Kayser of Marburg.
Prof. v. Zittel of Munich.
Prof. Lindström of Stockholm.
Prof. Nikitin } of St. Petersburg.
Prof. Lahnsen }
Prof. Barrois of Lille.
Prof. James Hall of Albany, N. Y.
Dr. White, Palæontologist, G. S. U. S. Washington.
Prof. Worthen of Springfield, Ill.

To all these my most sincere thanks are due.

There have yet to be mentioned the labours of my fellow-workers. In this respect I must before all offer my very best thanks to Dr. Conrad Schwager of Munich, who undertook the description of the Foraminifera His name is sufficient security for the *qua* that the work he has done will be found excellent, much better than it would have been if done by myself. To my two Assistants, Dr. Joseph Pichl and Dr. Joseph Wentzel, I am also under many obligations. Without their very material help it would have been impossible to finish the volume by the present date, and I may fairly say that their work has saved me several years of labour.

Thus, helped on to a great extent by the kind intervention of all these friends, the description of the entire fauna contained in the palæozoic beds of the Salt-range (with the exception of some things recently discovered by Dr. Warth, which I propose to describe in detail in the geological part, as they are chiefly of geological rather than of palæontological interest) has now been completed, and fills a volume of much greater extent than had ever been anticipated.

It would be extremely desirable now to enter directly upon the full discussion of the several species and their geological bearing, but the volume has extended already to such stupendous bulk that it does not seem practicable to give here all those details. This event was indeed anticipated by me when in the Introduction to the present volume I proposed to unite all the geological results in a separate volume, which would form the end of the series. A great part of the manuscript intended to form the first part of the fourth volume has already been sketched out, and it is only to be hoped that the Government will consent to the continuation of the work, so that I may be able to publish the geological results regarding the palæozoic strata at an early date.

In the Introduction to the Productus-limestone-Fossils, pp. 6—8 of the present volume, I stated my opinion that among the palæozoic strata of the Salt-range two extensive series should be distinguished: one lower, containing the "Saline series" and the "Purple sandstone" of Mr. Wynne, and one upper series, composed of the "Obolus beds (silurian)," the "Magnesian sandstone," the "Speckled sandstone," and the "lower limestone (carboniferous)" of Mr. Wynne's tables. For the upper series in general I have used the name of Productus-limestone, as the last of the members, quoted above, is the richest in fossils, and thus most conspicuous.

Thus, the whole volume receives the name "Productus-limestone-Fossils." Of subdivisions I at that time accepted five, but now, after the fossils have been described in detail, the number can be considerably augmented. The beds contained in this large series can be brought conveniently into three groups, each of which can be further subdivided. We arrive thus at the following scheme:—

I—Silicious limestone group.	Upper Productus-limestone.	Topmost beds.
		Cephalopoda bed.
		Lower beds.
	Middle Productus-limestone.	Upper beds.
		Middle beds.
		Lower beds.

II—Speckled sandstone group.	Lower Productus-limestone. Speckled sandstone.
III—Magnesian sandstone group.	Magnesian sandstone. Neobolus beds.

We thus arrive altogether at twelve subdivisions, of which six are of the first and six of the second order. In the lower two groups subdivisions of a second order cannot be distinguished, as fossils are very scarce.

Of all these divisions the upper and middle Productus-limestone are richest in fossils, and thus further subdivisions can easily be separated, each having a certain number of characteristic species. If we consider the fauna contained in these divisions quite in general, it cannot be denied that its aspect is entirely carboniferous, and a superficial inspection will lead every observer to suspect the beds in which such a fauna is contained to be of carboniferous age. But, on a closer examination, one will soon find that the several species are similar but not identical with carboniferous forms. Among the smaller and less conspicuous fossils one will soon detect a number of permian species; the number increases more and more, and at last one arrives at the conviction that the fauna is in reality permian—a permian fauna that is richer in forms and richer in conspicuous species than any one that has been described up to the present in the whole world.

At the same time its close relationship to the carboniferous fauna cannot be denied; and the thought cannot quite be rejected that the singular deviation of the European permian fauna from the carboniferous type is caused more by local influence than by a thorough change of the organic life over the whole world, and that in reality the permian organic life is in by far closer connection with the carboniferous than was anticipated by Murchison.

But, though on the whole the permian age of the upper and middle Productus-limestone cannot be doubted, yet its relation in detail to the European and American permian deposits cannot be made out until the geological relations of the several species have been worked out in detail, and I cannot at present give any indications in this direction.

In the lower Productus-limestone division the number of carboniferous species increases considerably, whilst of permian species only very few are met with. We thus may be justified if we consider these beds as transitional between permian and carboniferous and about corresponding in age to the sandstones of Artinsk, or to the beds of Nebraska city.

Regarding the beds still lower in position but very few indications as to their real age have come to light from the study of the fossils. I have tried to make it probable from the relations of the forms contained in the Neobolus-beds that these also were of carboniferous age; but this view was only reluctantly accepted, and from time to time objections were made against such a supposition.

I should not have been able to bring forward any new views in the matter were it not that my friend Dr. H. Warth has recently made some discoveries in the Salt-range, placing the whole question in a new light.

Some time ago in the Salt-range he detected in glacial deposits, included by Mr. Wynne in his "Olive Group," roundish nodules containing a rich fauna. I have given a preliminary notice of these contents in the Records, Geological Survey of India for last year, when I came to the conclusion that the species were partly identical with some fossils of the Australian carboniferous beds, and that they indicated with great probability a carboniferous age for the beds of the Salt-range in which they were found. Moreover, I brought the glacial deposit in which these nodules had been found into connection with other glacial deposits, which were not of rare occurrence in the Salt-range, and which generally were met with on the horizon of the speckled sandstone, and I arrived at the suggestion that both were of about the same geological age. All these suggestions were strongly and with some animosity objected to by Mr. R. D. Oldham, and the further conclusions I had drawn from all this were treated by him with contempt.

In the meantime, Dr. Warth continued his investigations with much success, and in a paper printed in the Records, 1887, part 2, page 117, he published the results of his new studies. What I had anticipated about two years ago, that the *Conulariæ*, when they were present in the Western Salt-range, could only be found there in the speckled sandstone (Wynne), has been fully proved now. Dr. Warth has traced the Conularia-bed into the Nila Wán, where he found the boulder-bed with *Conulariæ* underlying the sandstones of the lower Productus-limestone, which there make their first appearance. The boulder-bed itself has its position at the base of the speckled sandstone.

Dr. Warth, therefore, does not hesitate to place the boulder-bed of the Olive series and that of the speckled sandstone on the same horizon and to correlate with these the remaining boulder-beds of the Salt-range, all which he brings under the heading "crystalline boulder series"—a proceeding which I consider most appropriate. With this, it seems to me, a definite proof is now attained, that the speckled sandstone for its whole extent, or, as I perhaps should rather say, the crystalline boulder series, is of the age of the upper coal-measures.

Though this is a discovery of great importance in many respects, for which science will be greatly indebted to Dr. Warth, yet the question of the exact age of the Neobolus-beds has not yet been brought to a definitive solution by it. Nevertheless, it cannot be denied, that this discovery has at least a certain bearing upon that question. Up to the present it has always been possible for those, who did not wish to accept my views in this respect, to pronounce the speckled sandstones as an equivalent of the lower carboniferous, wherewith it would have been necessary to declare the lower following beds as older than carboniferous, and I must confess, that, though such a view would have hurt my palæontological feelings very much, I should not have been in a position to oppose it on very strong material grounds. Now, after Dr. Warth's discovery, it is impossible to make such a stand. The crystalline boulder series is proved to be of upper carboniferous age!

The rock-groups, which follow below are the (1) Pseudomorphic Salt-crystal Zone, (2) Magnesian sandstone, (3) Neobolus-beds. Of these the two latter are so intimately connected, that they can only be considered as forming subdivisions of one and the same horizon, and the first is of rather local occurrence, and has been formed under quite peculiar circumstances. Of the three the Neobolus-bed is the only one which is found to occur regularly over large tracts of country, the other two are more or less developed only locally, and must be taken as constituting only a local increase in thickness of the Neobolus-bed. This increase was brought about, as has been stated by me already on a former occasion, probably by the formation of dunes and back-waters at the mouth of a large river, which entered the sea in carboniferous times, coming from the south-east or south, somewhere in the region which is now occupied by the Eastern Salt-range.

If such was the case the three must be considered as forming one compact inseparable group. We can fairly say this group follows immediately below upper carboniferous beds, and must thus be of lower carboniferous age. I cannot see anything unreasonable in these deductions; and among all possibilities these seem to me again and again the most probable ones. The palæontological facts are decidedly in opposition to the view of these beds being silurian, not a single species or even genus being identical; and the geological facts, without straining them in any way, can be interpreted so as to let these beds appear as of carboniferous age.

Thus, as long as no direct proofs can be adduced, that these beds are really older than carboniferous, I consider myself justified in retaining my view, expressed already a long time ago.

After all that has been said, the name "Productus-limestone" can now as well be applied to the whole series as in the beginning of the work. The term must now be considered as a synonym of "Carboniferous" in the widest sense, if one considers the Permian as nothing but a subdivision of the carboniferous, as Bunter Musche kalk is a subdivision of the Trias.

With this I take leave of the public in expressing the hope that it may fall to my lot later on to treat more in detail of the more recent fauna of the Salt-range.

Prof. Dr. W. WAAGEN,
Oberbergrath.

Prague, May 1887.

SALT-RANGE FOSSILS.

Series XIII.

VOL. I.—PRODUCTUS-LIMESTONE FOSSILS.

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With 32 Photozincographs.

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,, V	,, ,,	771 to 834	,,	1st October 1885.
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ERRATA.

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On page 965, immediately after the wood-cut, read Fig. 34 instead of Fig. 32.

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PLATES.

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LONDON: TRÜBNER & CO.
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PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 8, HASTINGS STREET, CALCUTTA.

Class: BRYOZOA sive CILIOPODA.

(By William Waagen and Joseph Pichl, Assistant.)

Order: GYMNOLÆMATA.

Sub-order: CYCLOSTOMATA.

Family: *FENESTELLIDÆ.*

It has been an exceedingly difficult task to decide what should be considered as belonging to the *Bryozoa* and what not. With one group this decision has been comparatively easy, and this is the family *Fenestellidæ*, but with others it has not been so. It is well known that the *Chaetetidæ* and many other forms in connection with them have been considered by several authors, chiefly by Lindström and Zittel, as *Bryozoa;* and if these authors were right, a great many fossils occurring in the Salt-range would have had to be placed in this class. Already however Zittel was very doubtful as to the position of certain forms, as for instance of *Stenopora*, Lonsd., which also occurs plentifully in the Salt-range, but as these very forms are again most intimately connected with *Monticulipora* and allied genera, the position of these also must be questioned. It has now been possible to distinguish among the materials from the Salt-range a genus that will bear the name of *Dybowskia*, in which rudiments of two vertical radial septa exist, but which in all other respects agrees with *Monticulipora* and its congeners. There can be but little doubt that this new genus belongs to the corals, and from its intimate connection with other genera of tabulate corals, it appears highly probable that all the rest should be similarly placed. After this deduction there remained only two families of *Bryozoa* to be described here—the *Fenestellidæ* and the *Thamniscidæ*. There is no doubt that after careful search for the more minute creeping forms the number of families could be augmented, but for the present we must be contented to describe the larger most common and characteristic species.

It more especially regards the generic groupings of the family *Fenestellidæ* to remark, that most of the forms can easily be classed as soon as the two faces of the colony are known—the poriferous and the non-poriferous. This can however only rarely be achieved without much labour, as generally only one of the faces is naturally exposed, while the other adheres firmly to the supporting rock. It is usually the poriferous side which is thus concealed, as through the openings of the pores the rock-matter enters the interior of the colony, which thus becomes on that side most firmly attached to the rock. This circumstance is of not very material importance when collections can be made at leisure; for, with time and patient search, the poriferous side of every species will be found incidentally exposed. But in a collection made in travelling, as was that of the Salt-range, such careful selection of specimens cannot be made, and thus in very many cases all the specimens of a species show only one side. It has now been the task of one of us to make up this defect of the materials at hand, and to prepare them so as to expose if possible in every specimen the two faces of the colony. This has entailed fully two years of labour, and only after this was it possible to attempt a full description of the *Bryozoa*.

It is well known that in the family *Fenestellidæ* the two sides of the colony are very different, on one side are the pores, that is to say, the entrances to the dwellings of the animals while the other side is devoid of pores, being occupied by the so-called basal-plate, on which the cells severally take their origin. The cells are mostly pyriform, which results from their commencing in a long thin point, widening slowly, and again contracting to form the pore or entrance. In this family they are arranged in three different ways: either they form two series, each turned laterally, the entrances thus forming pores opening on the two sides of the branches; or they originate in the middle and turn to all sides, except towards the basal-plate, pores being irregularly distributed over the whole obverse side of the branches; or lastly, the basal-plate sends a vertically protruding plate into the interior of the branches, and the cells originate on both sides of this plate, thus occupying two triangular spaces. The basal-plate requires some words of explanation: it is not, as would appear from some descriptions, the basal part or root of the whole colony; nor is it a separate shelly plate dividing the poriferous from the non-poriferous side of the colony; it is simply the shelly substance of which the non-poriferous side is made up. It is often very thin, so much so even that the cells can be seen through it, as on Plate LXXXVII, figs. 2*b*, 4*b*; or it may be much thicker, as in Plate XC, fig. 1*c*. In all cases the basal-plate is composed of very numerous longitudinally extended fine capillary tubes, and appears either as a sort of incrustation or as a thin shelly layer; it is mostly provided with very fine pores. Its surface is either finely striated longitudinally, or smooth, or provided with little tubercles.

Such is the finer or more intimate structure of the branches of the colonies as occurring in this family.

In close connection with this structure is the outward appearance of the branches, which is chiefly influenced by the arrangement of the cells, producing typical differences between the several forms. The first mode of arrangement indicated causes a median keel to be formed on the poriferous side of the branches, on each side of which the pores are situated. By the second mode, the poriferous side of the branches is strewn all over with pores, mostly arranged in quincunx, and a median keel never occurs. The third mode of growth appears only in few forms; they have a median keel on the poriferous side, as well as on the non-poriferous one, and are thus very characteristically distinct from the rest.

These typical differences between the several forms belonging to the family *Fenestellidæ* have apparently been already recognised, in part at least, by Claypole, who in a recent paper read before the Geological Society of London brings certain forms of the *Fenestellidæ* into a more intimate connection, while excluding others from consideration. At the same time however he neglects a character which is of equal or even greater importance than the intimate structure of the branches; this is the existence of fenestrules. This character is the distinguishing one between the families *Fenestellidæ* and *Thamniscidæ*. Thus we cannot agree with Claypole in bringing the genera *Glauconome* and *Ichthyorhachis* into more close connection with *Fenestella* and the rest; we shall in accordance with Zittel's Hand-book place these genera in the family *Thamniscidæ*, but for the rest of the genera adduced by Mr. Claypole, we perfectly agree with that author in bringing them more closely together. This can however be done most simply, as in other parts of this work, by creating sub-families for the group of forms pointed out by Claypole as well as for the other typically deviating groups pointed out above. We thus come to create three sub-families—the *Fenestellinæ*, the *Polyporinæ*, and the *Goniocladinæ*.

Sub-family: *FENESTELLINÆ.*

All the genera belonging to this sub-family show colonies which form leaf-shaped reticulated expansions, either with a median axis and lateral branches, or with two lateral axes, or with one lateral axis, round which the expansion is spirally rolled up, or at last without axis at all, only fastened to the ground by a kind of root or thickened part. In all these differently shaped colonies the branches on the cell- or pore-bearing surface are provided in the middle with a prominent keel, on each side of which the cells are arranged in regular rows. The dissepiments by which the branches are connected are mostly without cells.

The genera belonging to this sub-family are the following:—

1. FENESTELLA, Lonsdale, 1839: Murch. Sil. Syst., pl. 15. The colony is fan-shaped or infundibuliform, without a marked axis; the pores are generally on the upper or interior side of the funnel; there is one row of pores on each side of the median keel on the branches. Silurian to permian.
2. FENESTRALIA, Prout, 1858: Transact. Acad. Sci. St. Louis, Vol. I, p. 235, pl. 15, fig. 1. Colony similar in shape to the preceding, but two rows of cells or pores on each side of the median keel on the branches; the keel extending to the dissepiments, but not the pores. Carboniferous.
3. SEPTOPORA, Prout, 1859: Transact. Acad. Sci. St. Louis., Vol. I, p. 448, pl. 18, fig. 2. Colony similar in shape to the preceding and agreeing with *Fenestella* with the sole distinction that the dissepiments also are poriferous. Carboniferous to ? permian (*Synocladia biserialis*, Swallow).
4. LYROPORA, Hall, 1857: Proc. Am. Assoc. Adv. of Sci., Vol. 10. Colony supported on both sides by strong stony axes diverging from the base between which the reticulated part is spread out; the arrangement of the pores as in *Fenestella*. Carboniferous.

5. Ptilopora, M'Coy, 1844: Synops. Carb. Foss. Ireland, p. 199-200, pl. 28. Colony flabelliform, with a strong median axis, from which rise on both sides branches that are connected by dissepiments; arrangement of the pores as in *Fenestella*. Carboniferous.
6. Helicopora, Claypole, 1883: Quart. Journ. Geol. Soc. Lond., Vol. XXXIX, p. 32, pl. IV. Colony flabelliform, turned spirally round an imaginary axis; the arrangement of the cells as in *Fenestella*. Silurian.
7. Archimedes, Lesueur, 1842: American Journ. of Sci. & Arts; Hall 1858, Palæont. of Iowa, p. 651. Colony flabelliform, turned spirally round a thick strong axis; the arrangement of the cells as in *Fenestella*. Carboniferous.

Other genera like *Disticheia*, Sharpe, *Carinopora*, Nicholson, *Cryptopora*, Nicholson, &c., might also belong to the present sub-family, but we are not sure on this point.

As will be seen from this list, the sub-family *Fenestellinæ* is of a chiefly carboniferous distribution, though the genus *Fenestella* begins in the silurian and extends to the permian period, and the genus *Helicopora* is exclusively upper-silurian.

In the Salt-range only the genus *Fenestella* occurs, and is represented there by two (perhaps three) species.

Sub-family: *POLYPORINÆ.*

The shape of the colonies occurring in the genera belonging to this sub-family is much less varied than in the preceding sub-family. Most of the genera have fan-shaped or infundibuliform colonies while only in exceptional cases a median axis occurs. The number of genera is also much less, whereby the smaller range of variation may be explained. The chief character of the family consists in the circumstance that the branches are covered all over with pores on one side, an arrangement depending, as has been explained above, on the internal structure of these parts. The genera belonging to this sub-family are the following:—

1. Polypora, M'Coy, 1844: Synops. Carb. Foss. Ireland, p. 206. Colony fan- or funnel-shaped; the pores restricted to the branches and absent on the dissepiments. Silurian to permian.
2. Phyllopora, King, 1849: Monogr. Brit. Perm. Foss., p. 40. Colony fan- or funnel-shaped; the branches as well as the dissepiments covered with pores; dissepiments and branches of equal thickness. Silurian to permian.
3. Synocladia, King, 1849: Monogr. Brit. Perm. Foss., p. 38. Colony fan- or funnel-shaped; the branches and dissepiments covered with pores; dissepiments angularly bent. Permian.
4. Dendricopora, Koninck, 1876-77: Rech. sur les Foss. paléoz. de la Nouv. Galles du Sud, 3^me^ partie, p. 169, pl. VIII, fig. 4. Colony dendritic with a strong median and several lateral axes, dissepiments very thin; obverse of the branches with three rows of pores. Carboniferous.

To these should be added the genus *Protoretepora*, Kon.; but it seems that this name should be better considered as only a synonym of *Polypora;* the sole difference between the two consisting in the circumstance, that in the one the pores are said to be placed on the inner, in the other on the outer side of the funnel-shaped colony. Such a position of the pores is evidently only accidental, depending upon the mode in which the quite young and still fan-shaped colony first became twisted; if towards the poriferous side, the pores remained on the inner side; if in the reverse direction the pores remained outside. It needs only to observe the irregular manner in which all these colonies bend in and out in every direction to become convinced that the same was the case also in the young stage, so that the position of the pores must be more or less accidental, and cannot be used for the distinction of genera.

The general geological distribution of this sub-family is similar to that of the preceding, but in the present one on the whole the several genera show a larger geological range.

In the Salt-range the present sub-family is more largely represented than the preceding one, three genera—*Polypora*, *Phyllqpora*, and *Synocladia*—being each represented there by several species.

Sub-family: *GONIOCLADINÆ*.

The most striking character of this sub-family consists in the circumstance that the branches of the colonies are compressed, not from front to back as in the other sub-families, but laterally, so that on the obverse as well as on the reverse side of the branches a highly projecting keel is produced.

The colonies themselves are fan-shaped or arborescent, and are above all characteristically distinguished by the circumstance that the branches and interstices are not well distinguishable, the whole forming a rather irregular network.

The genera belonging to this sub-family are :—

1. Goniocladia, Etheridge, 1876: Geol. Mag., dec. II, vol. III, p. 522. (= *Carinella* Etheridge). The colony is fan-shaped and forms an irregular net-work of tortuous anastomosing branches, producing generally hexagonal fenestrules. Both the poriferous and the reverse sides of the branches are strongly keeled. There are several rows of pores on both sides of the keel. Carboniferous to permian.
2. Ramipora, Toula, 1875: Neu. Jahrb. für Min. u. Geol., p. 230, pl. X, fig. 1. Colony arborescent, with a median axis bearing opposite branches, which again are provided with opposite branchlets; these latter anastomose and thus form an irregular net-work. Both faces of all these parts bear a strong keel, and on the poriferous side there are several rows of pores on each side of the keel. The genus occurs in the permo-carboniferous beds of Spitzbergen.

Of these two genera only the first occurs in the Salt-range, and has furnished there one species.

Sub-family: *FENESTELLINÆ.*

Genus: FENESTELLA, Lonsdale.

The colony, if perfectly preserved, is infundibuliform or fan-shaped, often of a very considerable size. It is composed of numerous thin dichotomous branches which originate at the root-like base and extend in a somewhat radial direction towards the periphery; they are connected together by thin straight dissepiments, giving a finely reticulated appearance to the whole colony. The round entrances to the cells or pores are distributed in two rows on the obverse side of the branches. Between these two rows of pores a high keel runs along, on the top of which smaller accessory pores are sometimes situated. These need not always be open; sometimes they are shut and replaced by little nodules, sometimes the openings are only slit-like. The dissepiments are devoid of pores, and form together with the intertices of the branches adjoining them more or less regular quadrangular or somewhat roundish fenestrules.

The basal-plate, which covers the non-poriferous side, is longitudinally striated.

The genus is well distinguishable from all the others of the family by the absence of any axis; by the two rows of cells on the branches separated from each other by a high keel; and by the dissepiments being devoid of pores.

The distinction of species within this genus is beset with great difficulties. It needs only a glance into Shrubsole's review of the British carboniferous *Fenestellidæ* to become convinced of this. Though we agree perfectly with that author as to the effects of age and preservation on colonies of this genus, yet we cannot detect in the Indian specimens differences due to those influences comparable in extent to those stated by him to occur in English species.

With progressing age the basal-plate especially increases considerably in thickness, and on the obverse side the pores seem sometimes to be closed, but the arrangement of the pores is never altered. In the peripheral parts of the colonies, differences due to preservation are caused to the extent that the accessory pores on the median keel are sometimes closed, sometimes open, and thus produce a rather different appearance of the branches, the arrangement of the primary pores or cell-openings is however invariable. Thus it appears to us that the chief characters for the distinction of species within this genus must be taken from the size of the branches and of the fenestrules, and from the arrangement of the cell-openings.

According to these views we can distinguish two species of Fenestella among the Indian materials. One of these is identical with an American species and will thus bear the name of *Fen. perelegans*, Meek; the other cannot well be identified with any species already described, and we therefore are obliged to introduce a new name for it: *Fen. jabiensis*, W. and P. The first of these occurs in the middle Productus-limestone, while the second is geologically somewhat younger, and extends from the top beds of the middle into the upper division of the Productus-limestone. A third species seems to occur in the Salt-range, but it has been found only in such an incomplete state of preservation that it is impossible to say anything positive of it. This form occurs in the *Neobolus*-beds and will be quoted as ***Fenestella* (?) *sp. indet.***

1. FENESTELLA PERELEGANS, Meek, Pl. LXXXVII. fig. 1-3.

1871. *Fenestella shumardi*, Prout?: Meek: in Hayden's final report on Nebraska, p. 153, pl. VII, fig. 3.
" *Fenestella perelegans*, Meek: *ibid*, p. 153, line 4 from below.

The colony is fan- or funnel-shaped, forming on the whole an exceedingly fine net-work.

The branches are straight, of equal thickness for their whole extent, and rather coarsely striated longitudinally on the non-poriferous side. They divide frequently and at rather regular distances into two, and are a little swollen at the point of division. Otherwise they extend tolerably parallel to each other.

The dissepiments bear a fine striation parallel with their longer extension. They are always thinner than the branches, and somewhat thickened at each end where united with the branches.

The fenestrules are oval or rectangular with rounded corners. They are always longer than broad, the length being about once and a half the breadth. The breadth of the fenestrules on the contrary is again only about one half the breadth of the branches. There are about 10 fenestrules within the space of 5mm. in the direction of the extension of the branches as well as in the transverse direction.

The comparatively large round cell-openings are in the specimens at our disposal on the inner side of the funnel formed by the whole colony. They form on each branch two alternating rows between which a very distinct keel extends. Their arrangement is with very remarkable constancy such that a pore is always situated at each end of the dissepiments and one on the interstices between, that is on the longer sides of each fenestrule. This is all that can be seen with an ordinary pocket lens. With a lens of stronger magnifying power one can however observe that the keel bears small accessory pores, which are sometimes closed, sometimes open; when they are closed, the keel forms a distinctly waved line, on which from distance to distance little swellings are observable; when the pores are open the waved line is resolved into a number of these very fine pores placed alternately along the top of the median keel.

The non-poriferous side of the branches is evenly vaulted and occupied by the so-called basal-plate. This bears generally a rather coarse longitudinal striation, and is often so thin that the cells can be seen through it. Towards the root of the colony the basal-plate becomes generally considerably thicker.

From this description it will already appear that all the parts of this species are of exceeding smallness. The whole colony however can attain the height of 50 to 60mm. and even more.

In one of the specimens (from Gulámi) the natural colouring of the species, a dark coral-red, seems to have been preserved.

Locality and geological position.—This is a rather rare species; there are only three specimens of it in the Salt-range collection. All three were collected in the middle Productus-limestone. One of them was found at Khura in the upper region of the middle division, another at Musakheyl, and the third at Gulámi, both the latter in the middle region of the same division.

Remarks.—There cannot, it seems, be much doubt that the Indian fossils are identical with the American species, to which they have been assigned by us, all the chief characters agreeing exactly in both forms. It must however be remarked, that it is only the name of *Fen. perelegans* that can be applied and not that of *Fen. shumardi*, Prout, which has been also adduced by Meek. The true *Fen. shumardi* though it has never been figured, can even from the description be stated to be altogether different from the form here under consideration. The number, as well as the arrangement of the cells adjoining each of the fenestrules, is quite peculiar in the Indian specimens, and Mr. Meek was thus very right in introducing a new name for the present form.

The species was originally described by Meek from division C of the Nebrasca section.

Of European species *Fen. nodulosa*, Phill., with which a number of other forms have been united by Shrubsole, can be compared. It is distinct from the Indian and American form by the less regular arrangement of the cells, two of which often occur along the margin of one fenestrule, a case which has never been observed in *Fen. perelegans*. Also the fenestrules themselves are of different dimensions.

Whether the specimens that have been described by Toula from Barentz Land near Novaia Zemlia, under the name of *Fen. cf. shumardi*, belong really to Prout's species, or should be united with the present one cannot be decided, because only the non-poriferous side is known, and even of this the indications are rather incomplete.

2. FENESTELLA JABIENSIS, Waagen & Pichl, n. sp., Pl. LXXXVII, fig. 4, Pl. LXXXVIII, fig. 1-2.

The colony very probably was infundibuliform, and increased very rapidly in size by the progressive augmentation of the branches.

The comparatively thick branches bifurcate frequently and within short distances. On the non-poriferous side they appear somewhat crooked. The dissepiments are on the same level as the branches, and form together with the interstices fenestrules of a roundish or oval shape. On the poriferous side, on the contrary, the branches appear almost quite straight and the dissepiments are deeply sunk between them, the fenestrules becoming more rectangular, with rounded corners. The dissepiments are generally but little narrower than the branches, and are somewhat broader at the place where they unite with the branches than in the middle. The fenestrules are narrower than the branches, and generally about twice as long as they are broad. Within the distance of 5mm. there can generally be counted 4 to 5 fenestrules in the direction of the extension of the branches and 6 in the transverse direction.

The small round cell-openings are equidistant from each other on the poriferous side, and are placed in two alternating rows on each side of the high median roof-shaped keel, and very near the margins of the fenestrules, whereby the latter often have an indented appearance. There are generally three to four pores within the space of one fenestrule, and so arranged that the first and the last occur just in the lower and upper corners of the fenestrule, or stand opposite the broadened termination of the dissepiment.

Along the top of the median keel a great number of very small accessory pores are somewhat alternately placed, but they can only be observed with a very strongly magnifying lens.

On the non-poriferous side the branches are flatly vaulted and indistinctly striated longitudinally. When the very thin basal-plate is removed by weathering or detrition, the cells can be seen as little tubes directed obliquely upward and outward.

There were three specimens of this species in the Salt-range collection, but only exposed to view on the non-poriferous side. In one of the specimens it was found possible to clear the opposite side from the adhering rock; but though this preparation answered all purposes of description, its characters could only be seen with difficulty and under favourable circumstances. Thus it has happened that the artist has not quite correctly represented the species in the drawings on Pl. LXXXVIII; it may then be pointed out that the pores adjoining the dissepiments are not in reality more distant from each other than the others along the margins of the fenestrules, the distribution being much more regular than is represented in the drawing. In the outermost branches on the right and on the left of the figure the drawing most nearly approaches the reality.

As to the size of this species, nothing can be indicated from the few fragments that have been found in the Salt-range.

Locality and geological position.—The species is represented in the Salt-range collection by three fragments. Two of these were found at Jabi in the Cephalopoda-bed of the upper division, and the third at Khura in the upper beds of the middle division of the Productus-limestone.

Remarks.—The present species belongs to a very remarkable group of forms within the genus *Fenestella;* it is distinct from all the rest of the same genus by the circumstance that the two faces of the colony have very different aspects, on the poriferous side the fenestrules appearing more or less rectangular, while on the other side they appear oval or nearly circular. This peculiarity is caused by the position of the comparatively very broad dissepiments in the plane of the non-poriferous side.

This group of forms is composed, as far as we are aware, of *Fen. veneris*, Fischer v. Waldheim, *Fen. fossula*, Lonsd., and the Indian species here under description. Of these three the *Fen. veneris*, Fisch., is geologically the oldest, having been described originally from the upper-carboniferous-limestone of Moscow. The Australian *Fen. fossula* may be about of the age of the coal-measures, and our Indian *Fen. jabiensis* belongs probably to the permian formation.

In the mountain-limestone proper this group of forms seems to be entirely absent.

As regards the specific distinction of the Indian form from other allied species, we must confess that it is very nearly related to the other species of the same group; nevertheless there are some differences which forbid a specific identification. The most nearly allied form is *Fen. veneris*, Fisch. As far as this species has been made known by Trautschold's description, which is however, we are sorry to say, rather defective, it seems that it is chiefly distinct from the Indian form by its smaller size. Trautschold counts 16 fenestrules in the longitudinal and 20 in the transverse direction within the space of 10mm. which indicates considerably smaller dimensions than in *Fen. jabiensis*. *Fen. fossula*, Lonsd. seems to agree nearly in size with our Indian form, but the indications given in the description are still more rudimentary than in the preceding case. Nevertheless according to the drawings given by Lonsdale, this Australian form also seems to be different from the Indian one, the difference being chiefly apparent in the condition of the keel on the poriferous side. In the Indian form the keel is furnished with a great number of very small accessory pores, which alternate and thus form a waving line; in the Australian form, on the contrary, there are few accessory pores of comparatively large size and so placed on the top of the keel that one accessory pore is always situated between two of the large cell openings. This difference seems sufficient to distinguish specifically between the Indian and the Australian forms.

Of other species *Fen. Popeana*, Prout, might perhaps be compared; but there is no drawing of this American form, and thus a comparison becomes very difficult. But from the description it seems that the American species can well be distinguished from the Indian one by the insignificant development of the keel on the poriferous side of the former.

Among the mountain-limestone species of Europe, *Fen. tenuifila*, Phill. resembles *Fen. jabiensis* by the similar distribution of the cell-openings. It belongs however to a quite different division of the genus, as it exhibits very thin dissepiments and rectangular fenestrules on both faces of the colony.

3. (?) FENESTELLA sp. indet., Pl. XCI. fig. 6.

In the grey slaty micaceous shales which form the *Neobolus*-beds in the gorge above the salt-mines of Khewra an impression which resembles a *Fenestella* has been found. So much can be stated that the branches are of a calcareous substance, but beyond this it was found impossible to make out anything.

Bad as this specimen is we thought it worth a short notice, as the bed in which it occurred has furnished up to the present only those remarkable Brachiopods of the order *Lyopomata* that have been described above. The occurrence of something like a *Fenestella* in these beds gives at least some hope that other fossils may yet be found in time.[1]

Sub-family: *POLYPORINÆ.*

Genus: POLYPORA, M'Coy.

The colonies of this genus are fan-, funnel-, or cup-shaped. They are composed of dichotomous branches rising from a common root. They are comparatively very thick, and already this gives to this genus a very characteristic appearance,

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[1] In the course of preparing the *Brachiopoda* I have detected another fossil. It was contained in a specimen labelled "Chel-hill" by Mr. Wynne, without indication of any horizon. The rock is exactly similar to the *Neobolus*-beds of other localities, but *Neobolus* itself and the other *Lyopomata* that generally are found with it are altogether wanting. The fossils in this rock-specimen are small *Hyolithes*, of which several specimens could be extracted. Mr. Wynne mentions in his report several bands of rocks at Chel-hill very similar in appearance to the *Neobolus*-beds, but far above these, in the Magnesian-sandstone, and the rock-specimen may have come from one of these bands. The species may best bear the name of—

HYOLITHES WYNNEI, Waagen, n. sp.

The subjoined woodcut represents the species in natural size and enlarged :—

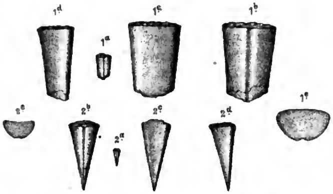

Fig. 25.—HYOLITHES WYNNEI, Waagen, n. sp. 1, fragmentary specimen with upper end partly preserved; 1 *a*, natural size; 1 *b*, view from the front; 1 *c*, view from the back; 1 *d*, lateral view; 1 *e*, section, the latter four figures enlarged; 2, small specimen with the apex preserved; 2 *a*, natural size; 2 *b*, *c*, *d*, *e*, different views enlarged (legend as in 1).

The whole fossil forms a small obtusely triangular pyramid, of which the larger face is concave near the apex and flatly vaulted near the aperture. The smaller faces are transversely vaulted for their whole extent, and are separated in the middle by a shallow longitudinal furrow. There are only internal casts known to me.

It seems that these little things do not agree with any species hitherto described. They seem to be most nearly related to *Hyolithes lanceolata*, Moris, from Australia, but deviate also from this form by the longitudinal furrow on the cast.

From *Hyolithes orientalis* W., described above, page 177, they are distinct by their larger size and quite smooth surface.

altogether deviating from *Fenestella*. The branches are connected together by numerous dissepiments, forming a net-work, showing either quadrangular or polygonal, or round fenestrules arranged radially in regular rows, which can be distinctly discerned extending from the root to the margin of the colony.

The branches are provided on one side (mostly the inner one) with numerous, 3 to 6 or 10, alternating longitudinal rows of pores. These latter are generally arranged distinctly in quincunx; they are round and their margin is often somewhat projecting from the surface of the branches. The cells in which the animals lived take their origin at the axis of the branches and rise from there in an oblique direction upward and outward. The dissepiments are without cells, though sometimes the cells extend on to them laterally from the branches so far that the space devoid of cells becomes very narrow. There is no keel on either side of the branches.

The non-poriferous side is occupied by the basal-plate, composed of one or more layers of capillary fibres, and is thus for the most part distinctly striated longitudinally. This basal-plate is usually of considerable thickness.

The specific distinctions within this genus are again very difficult, as there are no striking characters upon which they could be founded. All the species belonging to the genus seem at a first glance very much alike, and only after a more careful comparison are differences observed in the number of rows of pores on the poriferous side, in the size and arrangement of the fenestrules, and so on; but the entire absence of striking characters makes a grouping of the species extremely difficult. There might perhaps, as in *Fenestella*, be distinguished two groups, one which has still somewhat of a *Fenestella* in its habitus, and in which the poriferous and the non-poriferous sides are nearly identical in general appearance, and another group in which the poriferous side seems to bear much smaller fenestrules than the non-poriferous one. These two groups are however not very strictly distinct from each other, and it seems of not much practical value to make such a distinction.

The genus *Polypora* is extremely rich in species, but a great many of them have been described only from the non-poriferous side. Species begin to appear already in silurian strata, but the chief development of the genus seems to be attained in carboniferous times. In the permian formation it is still represented.

In the Salt-range we count eight species of *Polypora* which range through the whole extent of the Productus-limestone. In the lower division only a single species, *Polyp. vermicularis*, W. and P., has been found up to the present; it is restricted to that division. In the middle division the following six species occur, of which four are restricted to that division and two extend also into the upper division :—

Polypora koninckiana, W. and P.—middle and upper.
" *megastoma*, Kon.—middle.
" *gigantea*, W. and P.—middle.
" *ornata*, W. and P.—middle and upper.
" *sykesi*, Kon.—middle.
" *transiens*, W. and P—middle.

In the upper division there is only a single species, which is restricted to that division: *Polyp. biarmica*, Keys.

It thus appears that in the Salt-range the genus has its chief development in the middle division of the Productus-limestone. This may however be partly due to the local facies of these beds, as coral limestones.

1. POLYPORA KONINCKIANA, Waagen and Pichl, n. sp., Pl. LXXXVII, fig. 5, Pl. LXXXVIII, fig. 4, Pl. XC, fig. 1.

1863. *Polypora fastuosa*, Koninck: Quart. Journ. Geol. Soc. Lond., vol. XIX, p. 5, pl. X, fig. 4, (non *Gorgonia fastuosa*, Kon., 1844, *Polypora fastuosa*, Orb. 1847.)

1863. *Polypora fastuosa*, Koninck: Foss. Paléoz. de l'Inde, p. 20, pl. I, fig. 4.

This is one of the commonest species of *Bryozoa* in the Salt-range. There are numerous good-sized fragments in the Salt-range collection which all are flabelliform; it seems however that when complete the colony had an infundibuliform shape of considerable size. The branches composing the colony very often bifurcate at distances of from 6 to 12mm., whereby the whole net-work rapidly augments in lateral extension. The breadth of the branches is generally 2mm.; it must however be remarked that this breadth is not uniform; it is a little larger just before the branches divide into two, and a little smaller immediately after this division has taken place. On the non-poriferous side the branches appear much narrower, whereby a very different appearance of the two faces is produced.

On the poriferous side the surface of the branches is well rounded transversely. The dissepiments appear about one-half as broad as the branches, very short, and a little broadened at both ends. They bear a distinct striation parallel to their length. Owing to their small diameter they are sunk in between the branches, which project considerably above them chiefly on the poriferous side, so that on this side they nearly disappear between the branches and are situated in deep furrows.

The fenestrules, which are hemmed in by the branches and dissepiments, are of an elongately oval shape, about twice as long as they are broad. Their lateral margins sometimes appear indented, when the fenestrules are filled with stony matter in such a manner as to reach the first lateral row of cell-openings. There are about 4 fenestrules in a longitudinal, and 5 to 6 in a transverse, direction within the space of 10mm.

The large round cell-apertures have raised margins when the surface of the branches is quite well preserved; when this is not the case, these margins first disappear; and if the deterioration progresses further the cell-openings assume a rhombic aspect. These pores are regularly arranged in 5 to 7 alternating longitudinal rows, so that on the whole they are placed very regularly in quincunx. According to this arrangement, obliquely ascending rows of pores can be distinguished, each of which is generally composed of 5 to 7 pores, only just before the bifurcation of the branches 8 pores can sometimes be counted in the oblique row. Six of these rows terminate along the side of a fenestrule.

If the surface of the branches is perfectly preserved between the cell-openings fine longitudinal waving lines can be observed, by which these pores are partly surrounded.

The non-poriferous side of the colony is provided in the vicinity of the base with long root-like processes, devoid of cells and longitudinally striated. It is probable that these organs served as supports for the increasing colony. Also in other respects this side presents an aspect differing much from that of the poriferous side. The branches appear much narrowed, about of an equal breadth with the dissepiments and sometimes angularly bent. They cannot always be easily followed, on account of the small difference between them and the dissepiments. The fenestrules appear on this side much larger, somewhat rectangular, not much longer than broad, or even roundish.

The colony does not seem to have attained very large dimensions; the utmost size it ever reached may have been 50 to 80mm.

Locality and geological distribution.—The species seems to occur most numerously in the middle division of the Productus-limestone. It has been found in these beds in the middle zone (Virgal, 1 sp. and Vurcha, 1 sp.), and in the uppermost strata (Musakheyl, 2 sp.). The species extends however also into the upper division of the Productus-limestone, where it has been found in the *Cephalopoda*-bed at Jabi and at Chidru.

Remarks.—This species was originally identified by Mons. de Koninck with his *Gorgonia fastuosa* from the mountain-limestone of Belgium. It would therefore have been of much interest to compare original specimens of the two species, but this has, we regret to say, been impossible; Mons. de Koninck himself, in his great kindness, took much trouble to procure us a specimen of *Pol. fastuosa* from Belgium for comparison, but he did not succeed, as the species is so very rare. But in a letter addressed to one of us, he stated that he now thought his species was very materially different from the Indian fossil which he had formerly united with it, and that we ought to give a new name to the Indian form. We thus have decided to give the name of *Pol. koninckiana* to this fossil in order to express our gratitude to Mons. de Koninck for his kind and liberal endeavour to help us in our studies.

Mons. de Koninck expressed the opinion that the Indian form was distinct from the original *Pol. fastuosa* by broader branches and more numerous pores, an opinion that is perfectly borne out by the drawings in his "Déscription des Animaux Fossiles" Pl. A, fig. 5. From these drawings it appears that *Pol. fastuosa* has larger and more rectangular fenestrules, narrower branches and generally only five alternating rows of pores. Nevertheless *Pol. fastuosa* seems to be a very near relation of our *Pol. koninckiana*, and it is not improbable that the two stand in a developmental connection.

Other forms that have been described under the name of *Polypora fastuosa*, Kon., such as those mentioned by Toula from Barentz Land and Spitzbergen, are perhaps identical with the true *Pol. fastuosa*, but from *Pol. koninckiana*, here described, they deviate by different dimensions and a different number of pores.

Most nearly allied to the species here under description seems to be *Polypora marginata*, M'Coy, on account of its large cell-apertures and the presence of waving lines between them. The singular configuration of the branches, which is considered by M'Coy as the chief character of the species is probably only caused by a peculiar condition of preservation. From *Pol. koninckiana* it can be distinguished by its less numerous longitudinal rows of pores.

Polypora ampla, Lonsdale, might also be compared, but its preservation is generally so unsatisfactory that nothing definite can be made out. De Koninck, who makes it a distinct genus, *Protoretepora*, mentions only three rows of pores. This would remove it far from our *Pol. koninckiana*, though the dimensions and the shape of the fenestrules are similar. That it is very doubtful whether the genus *Protoretepora* should be retained has been mentioned already in the introduction to the genus *Polypora*.

2. Polypora megastoma, Koninck, sp.; Pl. LXXXVIII, figs. 3, 5, 6, 7; Pl. LXXXIX, fig. 3.

1863. *Fenestella megastoma*, Koninck: Quart. Journ. Geol. Soc. Lond., Vol. XIX, p. 5, pl. II, fig. 3.
1863. *Fenestella megastoma*, Koninck: Foss. paléozoiques de l'Inde.
1878? *Polypora megastoma* (Kon.) Etheridge: Quart. Journ. Geol. Soc. Lond., vol. XXXIV, p. 621.

The colonies of this species are on the whole fan-shaped, with a certain propensity towards the formation of irregular net-work of various shapes. In the parts of the colony adjacent to the root, the branches forming the net-work bifurcate much more frequently than further on.

The branches are on the poriferous side about 2mm. broad, and bifurcate generally within distances of from 5 to 15 or 20mm. Before the bifurcation takes place they are very little thickened, and the angle of bifurcation is flatly rounded off. In the peripheral parts of the colony the branches appear more or less parallel to each other, while in old specimens and in the parts neighbouring the root, the bifurcation occurs so often that no parallelism can be observed.

The short horizontal dissepiments are either alternating or nearly opposite to each other. Their breadth is about half that of the branches, but they are somewhat broadened at both ends. They are distinctly striated longitudinally, and their surface is on the whole on a much lower level than that of the branches.

The fenestrules are more or less rectangular, with rounded corners. They are always longer than broad (about 2½ to 3mm. long and 1¼mm. broad), and three of them measured in the longitudinal direction occupy the space of about 12mm. Within the same space there can be counted 4 to 5 rows in the transverse direction.

The round cell-openings, which however appear in weathered surfaces more or less rhombic, are very numerous, arranged very regularly in quincunx, forming 7 to 10 alternating longitudinal rows. In this arrangement also oblique rows can be distinguished, ascending from both sides and intersecting. The number of pores in these rows is seven to ten. Of these obliquely ascending rows there can be counted about eight along the lateral margins of one fenestrule. Sometimes the pores extend rather far on to the dissepiments, so that the poreless space on these latter becomes very narrow.

On the non-poriferous side the branches appear much thinner and angularly bent, following more or less a zig-zag line. Sometimes they bear root-like longitudinally striated prominences without pores. The dissepiments are on the same level as the branches, are nearly as broad as the latter, and somewhat broader at both ends. The whole surface of the non-poriferous side is covered with very dense, waving, fine longitudinal striations.

The present species can attain very considerable dimensions. There are badly preserved fan-shaped expansions in the Salt-range collection probably belonging to the present species, with a diameter of about 150mm., although the root and the margin have been broken off. Thus we may take the size of complete specimens to be at least 200mm.

Locality and geological position.—This is again a rather common species in the Salt-range, but seems to be restricted to the middle division of the Productus-limestone. There are seven specimens, of which three come from Morah, one from Ramkhund, and two from Káfirkót from the middle region of the division; while two others have been found at Khura in the uppermost beds of the same division.

Remarks.—This species is very well characterised by the large rectangular fenestrules, by the numerous rows of pores, and by the circumstance that the bifurcation of the branches is also easily discernable on the non-poriferous side. By all these characters it is also distinct from the preceding *Pol. koninckiana*, W. and P. It must however be noticed, that when the preservation is exceptionally good, similar waving lines extending between the pores can sometimes be distinguished in *Pol. megastoma* as well as in *Pol. koninckiana.*

Mons. de Koninck originally described this species under the name of *Fenestella megastoma.* Already the size of this form and the thickness of the branches suggested to us that it was a *Polypora,* and the preparations made quite confirmed this supposition. That the forms we comprise under the name are really identical with those so described by Mons. de Koninck, is clearly shown by the non-poriferous side of our specimens, which are absolutely identical with Koninck's drawing.

The species has been also quoted by Mr. Etheridge from Feilden Isthmus in the arctic regions. It is highly probable that Etheridge's determination is right, but the indication cannot be controlled, as no figure is given.

As far as we are aware of, there is no other species with which *Pol. megastoma* could be more particularly compared.

3. POLYPORA GIGANTEA, Waagen and Pichl., n. sp., Pl. LXXXIX, figs. 1, 2.

The colony forms very large fan-shaped expansions, consisting of a net-work of very large meshes.

The branches are round, comparatively thin, not broader than 1·5mm. They divide frequently, not always only dichotomously, but sometimes three or even more branches originate at the same spot. The splitting of the branches generally takes place at distances of from 10 to 20mm., corresponding to a distance of from one to three fenestrules, whereby the colony very quickly attains considerable dimensions in breadth. Before the division of a branch takes place, it is a little swollen, and the new branches diverge in such a manner as to leave a fenestrule of normal size between them. Otherwise the branches extend tolerably parallel to each other keeping a distance of about two millimetres. In some silicified specimens the non-poriferous side of the branches is weathered in such a manner as to present the appearance of a median longitudinal keel with the cells arranged in oblique lines on each side of it. A superficial observer would easily take such specimens as belonging to the genus *Fenestella*.

The dissepiments are short and thin, barely showing more than one-third of the thickness of the branches. On the poriferous side their surface is on a lower level than the surface of the branches. They are finely striated longitudinally, and slightly thickened where they unite with the branches.

The fenestrules are somewhat unequal in size, very elongately rectangular, with rounded corners, varying from 5 to 9mm. in length and 2mm. in breadth. Two fenestrules occupy about the length of 13mm. At the points where the branches divide the fenestrules are sometimes much smaller and round.

The cell-openings are round and very numerous, and are arranged pretty regularly in quincunx. They form 7 to 9 alternating longitudinal rows, which extend on the lateral parts of the branches, rather low down towards the non-poriferous side, in such a manner that their full number can only be counted, when the branches have been cleared all round from the adhering rock. Between the pores extend waving longitudinal lines, which are bent in such a manner that the single pores appear as if situated in the middle of a hexagonal space.

The non-poriferous surface does not deviate in its general aspect from the poriferous one. It is covered all over with a fine longitudinal striation.

This species seems to have attained a very considerable size. Specimens of 150mm. in diameter are mere fragments without the upper or lower parts; it seems probable that the entire colony may have attained at least 500mm. in height. This seems to be the largest species existing within the genus.

Locality and geological position.—Specimens of this species are rather rare. They are restricted to the middle region of the middle division of the Productus-limestone and have been found up to the present at three localities: at Vurcha (1 sp.), at Mora (1 sp.) and Trans-Indus at Rámkhund (1 sp.).

Remarks.—This beautiful species is distinguished from all others known to us by its great size, by the extremely large elongately rectangular fenestrules, and by the great number of longitudinal rows of pores. *Pol. gracilis*, Prout, which may perhaps be more particularly compared, has thinner branches, less regular fenestrules and only four to five rows of cells. By similar characters can be distinguished *Pol. laxa*, Phill., sp.; *Pol. macropora*, Eichw. or *Pol. concatenata*, Eichw.

4. Polypora ornata, Waagen and Pichl., n. sp.; Pl. LXXXIX, figs. 4, 5, 6; Pl. XC, figs. 2, 3, 4.

The colony is largely infundibuliform and irregularly folded.

The branches are about 1mm. broad. They are flatly vaulted on the poriferous, as well as on the other side, and bifurcate very frequently in the vicinity of the root of the colony, while such bifurcation more rarely takes place in the peripheral parts. Just before the bifurcation the branches are generally somewhat broadened, and after it somewhat thinner. They extend generally parallel to each other, only in the folded peripheral parts of the colony the bifurcation as well as the extension of the branches is more irregular. The branches are commonly much altered by weathering, and then occasionally exhibit a rather strange appearance, being either quite flattened or bearing a sharp edge in the middle.

The dissepiments are short, about one-half as broad as the branches, and their surface is on a level only very little lower than that of the branches. They are somewhat broadened at both ends, indistinctly striated longitudinally, and the space devoid of pores is very narrow.

The fenestrules are about 1mm. in diameter. On the poriferous side they are somewhat smaller, oval in shape and longer than wide. On the non-poriferous side on the contrary they appear larger, mostly circular or also sometimes a very little longitudinally oval, but rarely somewhat broader than long. In much weathered specimens they often form deep funnels of a somewhat hexagonal circumference, and are separated from each other by high sharp crests (Pl. XC, fig. 2). They are arranged in such a manner, that not only longitudinal rows, but also obliquely ascending transverse rows can be distinguished. Within a length of 10mm. five to six fenestrules can be counted in the longitudinal direction, while there are always six within the same length in the tranverse direction.

The cell-openings are round, numerous, and are situated on the internal side of the infundibuliform colony. The pores are generally arranged regularly in quincunx and forming six alternating longitudinal rows on each branch. Just before the branches bifurcate they become broader, and at the same time also the number of pores is augmented, so that in this position eight rows can often be distinguished, but then also the arrangement is irregular and not in quincunx. The oblique rows of pores, ascending from both sides and intersecting each other, comprise generally from six to eight pores. Three to four of such rows terminate generally along the lateral margins of each fenestrule. Between the pores there extend fine waving longitudinal lines, causing the whole surface of the branches to be covered by a somewhat rhombic sculpturing. About where the corners of four of these rhombs approach each other minute adventitious pores occur (Pl. LXXXIX, fig. 6*b*.).

The non-poriferous side has an aspect somewhat different from that of the other side on account of the circumstance that the branches appear narrower, the fenestrules large and more roundish, and very often assuming an infundibuliform shape. The surface of the non-poriferous side bears a coarse longitudinal striation, covered by a not very fine granulation.

This is again a form which grew to very large dimensions. In specimens attaining a diameter of 200mm. the infundibuliform shape of the colony is no longer well marked, because in large specimens the colony spreads out almost horizontally, and often stops growth at one side much earlier than on the other, so that rather fan-shaped specimens are then produced. In specimens of this description the substance is so much thickened and incrusted that one cannot be sure which of the two sides is the poriferous one.

Locality and geological position.—The present species is not a common one, though it extends through the middle and upper divisions of the Productus-limestone. In the middle division it has been chiefly met with in the hard limestones of the middle region, and has been collected in these beds at Morah (1 sp.) and at Omarkheyl (1 sp.). In the upper division specimens have been collected in the lower and middle regions at Bilot (1 sp.) and at Khura (2 sp.).

Remarks.—In respect of the size and shape of the fenestrules, the present species shows a certain similarity to *Pol. orbicrebrata*, Kays., of the carboniferous limestone of Petschora Land. There exists however a striking difference between the two in the smaller number of longitudinal rows of pores in the Russian species. Another species that might be compared is *Pol. subquadrata*, Toula, from carboniferous beds of Barentz Land. In this, as in the preceding species, a small number of alternating longitudinal rows of pores can be distinguished, in this case only four rows.

Pol. cyclopora, Eichw., shows a similar number of rows of pores as our *Pol. ornata* (7—8 rows), but the bifurcation of the branches has a different character, and the fenestrules are more angular. As however there exists no figure of the poriferous side a more close comparison is difficult.

On the whole the present one seems to be a well characterised and easily distinguishable species, which can chiefly be recognised by a poriferous side showing broad branches and dissepiments and small round or oval fenestrules, while the latter appear larger and often infundibuliform on the non-poriferous side.

5. POLYPORA SYKESI, Koninck, sp.; Pl. XCI, figs. 1, 2.

1863. *Fenestella sykesi*, Koninck: Quart. Journ. Geol. Soc. Lond., Vol. XIX, p. 5, Pl. I, fig. 1.
1863. *Fenestella sykesi*, Koninck: Fossiles paléoz. de l'Inde.

The colony was very probably infundibuliform, with irregular folds towards the periphery, some lobes of which were entirely rolled in.

According to different modes of growth and preservation the rather thin branches appear sometimes tolerably straight, sometimes angularly bent, following a zig-zag line, in which latter case their non-poriferous side is often weathered so as to appear carinated; they bifurcate frequently, within distances of from 8 to 16mm. and their breadth augments very considerably before the division takes place. In folded specimens the ramification is much more irregular, and on the enrolled peripheral lobes the branches appear thicker and the fenestrules larger on the convex than on the concave side.

The generally alternating dissepiments are short, but little narrower than the branches, and somewhat broadened at both ends.

The fenestrules are nearly circular on the non-poriferous side, and longitudinally oval on the poriferous one. They form generally very distinct longitudinal rows, which more or less alternate so that the fenestrules on the whole appear very regularly arranged in quincunx as in *Phyllopora*. There are generally 6 to 7 fenestrules within the distance of one centimetre in the longitudinal direction. Transversely it is very difficult to take measurements, on account of the alternating arrangement of the fenestrules.

It has been found impossible to clear the poriferous side of the present species from the adhering rock, as all the specimens in the collection were preserved in such a hard siliceous or sacharoid limestone that the substance of the specimens was found to be less hard than the matrix in which they were contained. Consequently nothing could be done, but to make the pores visible by grinding down the non-poriferous side to near the poriferous surface. By such means it was ascertained that there were five alternating longitudinal rows of pores, and that the pores were very regularly arranged in quincunx. By this arrangement oblique rows are produced ascending from both sides and intersecting each other. There are four to five pores contained in each oblique row, and about four of such rows terminate along the lateral margins of one fenestrule. On the dissepiments there is but a narrow space free of pores.

The surface of the non-poriferous side is finely striated longitudinally.

The present species seems to have attained no considerable dimensions, as all the specimens at our disposal are of a very moderate size; it is not probable that the species ever exceeded 100mm. in height.

Locality and geological position:—Pol. sykesi is a rather rare species. It is entirely restricted to the massive limestones in the middle region of the middle division of the Productus-limestone, and has been found at Katta (2 sp.), at Morah (1 sp.) and at Musakheyl (1 sp.).

Remarks:—There has been figured by Mons. de Koninck, in his description of the fossils collected by Dr. Fleming in the Salt-range, a *Fenestella sykesi*, which is represented from the non-poriferous side; the original has been lost. Under such circumstances we could only select among our materials specimens in which the non-poriferous side most nearly agreed with that of *Fen. sykesi* as represented in the drawing, and then attempt an identification. Of the original specimen of *Fenest. sykesi*, the poriferous side was not known at all, and thus that specimen may as well have been a *Polypora* as a true *Fenestella*, and the comparative thickness of the branches suggests its *Polypora* nature. In specimens which we thought proper after most careful comparison to unite with Koninck's species, we soon detected numerous rows of cells and thus had to place them in the genus *Polypora*.

The present species varies very much according to its different states of preservation. Specimens in which the non-poriferous side is well preserved have the aspect represented in Mons. de Koninck's figure, and which is also exhibited in our figure Pl. XCI, fig 1. If however the specimens are more strongly weather-worn, then the fenestrules appear funnel-shaped, the branches narrower, and crested. Such a specimen is represented in Pl. XCI, fig. 2.

To this latter form the European species, *Polypora papillata*, M'Coy, can be compared. It is however distinct from the Indian species by narrower branches and less numerous rows of pores.

6. POLYPORA BIARMICA, Keyserling, Pl. XC, figs. 5, 6, 7.

1846. *Polypora biarmica*, Keyserling: Reise in das Petschora-Land, p. 191, pl. III, fig. 10.
1859. *Polypora biarmica*, (Keys.) Prout: Transact. St. Louis Acad. of Sci., I, p. 450.
1861. *Polypora biarmica*, (Keys.) Geinitz: Dyas, II, p. 117.
1866. *Polypora biarmica*, (Keys.) Geinitz: Carbon & Dyas in Nebrasca, p. 68, pl. V, fig. 13.
1872. *Polypora sp. indet.* Meek and Hayden: Final Rep. Geol. Surv. Nebrasca, p. 155, pl. VII, fig. 6.
1877. *Polypora biarmica*, (Keys.) Miller: Amer. Palæoz. Foss., p. 99.

The colony is apparently spread out in a flat funnel, the margins of which are sometimes irregularly folded.

The branches are straight, always broader than the fenestrules, and their appearance is rather different, according to the different sides of the colony. On the poriferous side they appear rather stout, frequently and regularly bifurcated, and considerably broadened just before the bifurcation takes place. Their surface is flatly vaulted. On the non-poriferous side, on the contrary, they appear thinner and not quite so straight. In specimens in which the curvature is stronger, the bifurcation of the branches becomes more irregular, and these are themselves very closely approximated to each other.

The dissepiments are very short on the poriferous side, or even barely distinguishable, in cases when the branches are very closely approximated. They are about half as broad as the branches, and situated at a somewhat lower level than the surface of the latter. On the non-poriferous side they appear somewhat longer and are situated about in the same level as the surface of the branches.

The fenestrules again appear very different according to the different sides of the colony. On the poriferous side they are very small, elongately oval, generally about ⅔ as broad as they are long, sometimes however much narrower and slit-like. They are often arranged in quincunx and seem to form obliquely ascending rows.

The sides of them appear sometimes indented by the somewhat projecting cell-openings. On the non-poriferous side the fenestrules appear nearly circular, only rarely oval.

There are four to five fenestrules within a length of 5mm. in the longitudinal direction, and in the transverse direction there are generally five to six within the same distance.

The large round cell-apertures have slightly projecting margins. They generally are arranged in three to four alternating longitudinal rows. Mostly one finds only three rows immediately after a bifurcation has taken place, higher up four rows may be distinguished, while on the broadened part of the branch just below the bifurcation up to six rows may be distinguished. In the obliquely ascending rows, formed by the alternating position of the pores, generally three pores can be counted composing one row, while more rarely four such pores occur. Along the lateral margins of one fenestrule generally two such oblique rows terminate, more rarely one or three. The pores often extend laterally so far on to the dissepiments that only a very narrow space remains free of pores, which is sometimes barely recognisable. In the only specimen at our disposal showing the non-poriferous side, this surface is not longitudinally striated, but covered with comparatively large round pores or holes, which are quite irregularly distributed, and might be mistaken for real cell-openings.

The size of this species seems to have been very moderate, but there is no entire specimen known to us, and thus we cannot give any positive indications.

Locality and geological position.—There are only two specimens of this species in the Salt-range collection, so it would appear that the form was very rare. It is moreover entirely restricted to the upper division of the Productus-limestone, in which it has been found up to the present only in the Cephalopoda-bed at Jabi (1 sp.) and at Chidru (1 sp.).

Remarks.—It is of much geological interest to find this permian species represented in the Salt-range, and on this account the identification calls for some further remarks. It would have been very desirable to compare the Indian specimens with authentic specimens of *Pol. biarmica*, but it seems that Count Keyserling's species is also a very rare one, as in none of the large museums which I had occasion to study more in detail, were specimens of the species to be found, and all endeavours to procure specimens for comparison failed. We thus were compelled to content ourselves with the comparison of our Indian materials with Keyserling's drawings, and this comparison was entirely in favour of an identification, as the Indian specimens seemed to be in every respect identical with Keyserling's description and figures, with the sole exception that the net-work of the Indian forms is perhaps a very little finer than in the Russian specimen from which the species was originally described. The difference is however a very small one, such as can be often observed in fragments from different parts of one and the same colony, and cannot prevent our placing the Indian specimens in Keyserling's species.

The specimen from division C of the Nebrasca city section, and identified by Geinitz with *Pol. biarmica*, seems to us quite correctly identified, though Meek, in his endeavour to dispute the permian age of these beds, has doubted that determination.

The species is however of a type which is not exclusively permian, but commences already in the upper carboniferous-limestone of Russia, where *Polypora martis*, Fisch, is a very characteristic representative of it. It is very much to be regretted that Trautschold's enlarged figure of this species is so very defective, and that no representation of the species in natural size was given. As far as can be made out from Trautschold's description and figure, this species of Fischer's can at all events be distinguished from our Indian specimens of *Pol. biarmica*, as these have a finer net-work. Whether such is the case with European specimens of *Pol. biarmica*, I cannot positively assert, but it is highly probable. If it be so, the *Pol. martis* must be considered beyond doubt as the ancestor of *Pol. biarmica*, and thus the two must be brought into developmental connection.

The existence of this very nearly allied form in geologically older beds makes other quotations of *Pol. biarmica* appear a little doubtful. Thus the form that has been described by Toula from Barentz Land may well belong to *Pol. martis*. The same is the case with the *Pol. biarmica* quoted by Etheridge from Fielden Isthmus.

In the older beds of the carboniferous formation, in the mountain-limestone, so far as we are aware of, there is no species closely related to *Polyp. biarmica*. The only form which might be compared is *Pol. papillata*, M'Coy, which is very similar to the species here under consideration in the size of the fenestrules and in the number and general arrangement of the pores. It can however be well distinguished from *Pol. biarmica* by the more zig-zag bending of the branches, the longer and thinner dissepiments, which are entirely free of pores, and by the position of the pores regularly in quincunx. The American species *Polypora varsoviensis*, Prout, is very similar to *Pol. biarmica;* it may even be the same as Keyserling's species, or perhaps it should be identified with *Pol. martis*, Fisch.

7. POLYPORA VERMICULARIS, Waagen and Pichl., n. sp., Pl. XCIV, fig. 7.

The colony is irregularly infundibuliform, with thick worm-like branches extending from the root upward between the more regular net-work.

The two sides of the colony are very different in aspect. The poriferous side shows the thick branches much less prominent, the fenestrules appear much narrower, and the branches of the net-work in consequence much broader than on the non-poriferous side, whereby a very different aspect is produced. The poriferous side is however known to us only from a comparatively small preparation; so we shall first describe the non-poriferous side.

The branches appear on this side of very unequal thickness and very different in aspect. The greater part of the colony is composed of comparatively thin branches having a very uniform breadth of about 1 to 1½mm. They are angularly bent, following a more or less irregular zig-zag line, producing a tolerably regular net-work with the fenestrules sometimes approximately rectangular, sometimes polygonal.

Among these there extend thick round branches, which attain in the vicinity of the root a thickness of 3mm. decreasing and increasing again in thickness at irregular intervals. They bend deviously in all directions, sometimes bifurcating, sometimes remaining undivided for long distances. Their highly vaulted surface projects far above the level of the surrounding net-work.

The ramification of all the branches is extremely irregular and can be followed only with difficulty.

The dissepiments are very short, and either alternate or occur opposite each other along the branches. They are of about the same thickness as the branches, and lie on the same level with them on the non-poriferous side which is that immediately under description.

The fenestrules are of rather unequal size, and very variable in shape. Where the net-work is a little more regular and where the thicker sporadic branches do not interfere, the fenestrules are generally about twice as long as they are broad, that is to say, 2 to 2½mm. long and 1mm. broad. There are about three fenestrules within a length of 10mm. in the longitudinal direction, while in the transverse direction five longitudinal rows of fenestrules can be counted within the same distance.

The surface of the non-poriferoûs side is occupied in this case by an enormously thick basal-plate, which is composed of extremely numerous thin capillary tubes, producing a very fine longitudinal striation of the whole surface between which numerous small pores are visible.

The poriferous side, as far as it is known to us, is different from non-poriferous side chiefly by the greater breadth the branches seem to possess and the longer and narrower fenestrules. The pores with which the branches are covered, are very numerous, closely packed together and very regulary arranged in quincunx. There can be distinguished seven to nine alternating longitudinal rows of pores, and also, from the arrangement in quincunx, obliquely ascending rows, intersecting each other from both sides, each consisting of eight to ten pores. Along the lateral margins of each fenestrule seven to eight such oblique rows terminate. Between the pores fine waving longitudinal lines are distinguishable. On this side of the colony the fenestrules appear long and very narrow, generally three times as long as they are broad.

The dissepiments are placed at a much lower level than the surface of the branches.

As to the size the colony may have attained we are unable to decide as only a single specimen is at our disposal. It is however probable that it formed part of a rather large infundibuliform net-work.

A point yet to be noticed with regard to this fossil is its dark coral-red colour, in striking contrast with the black rock in which it is contained; it may perhaps be the original colouring.

Locality and geological position.—The only specimen of this species in the Salt-range collection was found by Mr. Wynne in the Bukh Ravine, preserved in a black sandy limestone which there forms part of the lower division of the Productus-limestone.

Remarks.—The present species is very characteristically distinguished from all other species of the genus by the very irregular construction of the net-work, the very numerous and closely arranged cell-openings and the size and shape of the fenestrules. There is no described species known to us with which it could be more closely compared.

8. POLIPORA TRANSIENS, Waagen and Pichl., n. sp., Pl. XCI, figs. 3, 4, 5.

The colony was probably largely infundibuliform, in its outward appearance much resembling *Phyllopora*.

The branches are about 1mm. thick, angularly bent, following very distinctly a zig-zag line. In the lower regions of the colony they bifurcate rather frequently and regularly; in the upper parts on the contrary such a bifurcation takes place only very rarely, and the branches extend tolerably parallel to each other.

The dissepiments are short and on the non-poriferous side are of the same breadth as the branches. On this side they are also not depressed, but on the same level as the surface of the branches. On the poriferous side on the contrary they are depressed below the level of the surface of the branches, are narrower, and broadened at both ends.

The fenestrules are mostly arranged in alternating rows, so that distinct oblique intersecting rows can also be made out. In well preserved specimens they appear on the non-poriferous side hexagonal with rounded corners. Those however which do not alternate have a more rectangular shape. In specimens which are much worn by weathering, the fenestrules appear regularly oval. They are generally 2mm. long and 1⅓mm. broad. Within a length of 10mm. there are generally three fenestrules in one longitudinal row. Measured along one of the oblique rows there are about four within the same distance.

On the poriferous side the fenestrules appear considerably smaller and regularly oval.

The cell-openings are regularly arranged in quincunx and form six to eight alternating longitudinal rows. They extend very far on to the dissepiments, so that generally only a very small space remains free of pores, in some cases this space becomes even so small that it appears quite obliterated. Along the lateral margins of each fenestrule there terminate about six oblique rows of pores.

The surface of the non-poriferous side is very finely striated longitudinally, often so finely that the striation even with a lens can barely be distinguished. From distance to distance little calcareous protuberances, which probably served for the partial support of the colony and must be considered as root-like organs, are observable. They are probably identical with similar organs which have been described by us in *Polypora koninckiana.*

The species has apparently attained very considerable dimensions; from the fragments in the collection it can be judged that the colony, if entire, had a height of at least 150 to 200mm.

Locality and geological position.—The present species is entirely restricted to the middle division of the Productus-limestone, and has been found in several tolerably large fragments at Morah in the hard limestones which compose there the middle zone of that division.

Remarks.—If one takes only the non-poriferous side into consideration, then the *Pol. transiens* forms a member of a series of forms which commences with *Pol. sykesi,* Kon., proceeds by *Pol. ornata,* W. & P. and *Pol. koninckiana,* W. & P. and terminates with *Pol. megastoma,* Kon., in which series the *Pol. sykesi* is the form which possesses the smallest fenestrules and *Pol. megastoma* the one with the largest fenestrules. *Pol. transiens,* W. & P. would then hold a place between *Pol. koninckiana* and *Pol. megastoma.* It cannot be subject to much doubt, that all these forms are more or less related to each other; they are however not only different from each other in size, but when the poriferous side is also taken into consideration, one finds that the number of longitudinal rows of pores is different in the different species, and that also the arrangement of the pores is subject to great variation. The species here under consideration is distinct from all the rest by dissepiments, which are of the same breadth as the branches and bear pores nearly for their whole extent. At the same time the fenestrules are arranged more or less distinctly in quincunx, which causes a general appearance very much like that of *Phyllopora.* All these circumstances exhibit the present species as a sort of transitional form between the genera *Polypora* and *Phyllopora.*

What caused us rather to describe it as belonging to the former genus than to the latter was the distinct bifurcation of the branches, which is apparent at least in the lower parts of the colony, and the general occurrence of a space free from pores on the dissepiments.

Of non-Indian species there is none to which the present one could be more particularly compared.

Genus: PHYLLOPORA, King.

The materials of this genus preserved in the Salt-range collection are, we regret to say, very scanty, and it is with difficulty that we are able to distinguish the species which have been already described by Mons. de Koninck from the same ground.

As regards the forms which we believe should be ranked in this genus, we think they ought to exhibit the following characters.

The colony infundibuliform, with folded expansions at the margin composed of anastomosing tortuous branches joined together from distance to distance in such a manner that a compact shelly plate is formed, pierced by round or oval openings, and in which the branches can be traced only with great difficulty. The cells are in their position very characteristic: they ascend only for a very short distance along the basal-plate and then bend directly outward, thus becoming nearly vertical to it.

The basal-plate, which occupies the non-poriferous side of the colony, is mostly thick and composed of numerous fine capillary tubes. Its surface is either longitudinally striated or granulated.

The genus is distinct from *Fenestella* and its allies as well as from *Polypora* by the absence of dissepiments devoid of pores.

According to this diagnosis several specimens in the collection must be considered as belonging to the genus; they are however mostly only small fragments. Two of these forms can be united with species that have been already described by Mons. de Koninck, and a third one indicates the existence of a new species. The greater number and the best preserved specimens can be easily identified with *Phyllopora cribellum*, Kon. The identification of another small fragment with *Phyll. haimeana*, Kon. is not so certain. The third species is also represented only by a small fragment and will bear the name of *Phyllop. jabiensis*, W. & P.

Of these the two first named occur in the middle division of the Productus-limestone, whilst the third was found in the Cephalopoda-bed of the upper division.

None of these species has been found up to the present anywhere else in the world except in the Productus-limestone of the Salt-range.

1. Phyllopora jabiensis, Waagen & Pichl., n. sp., Pl. XCII, fig. 1.

The shape of the colony cannot be made out, as only small fragments of the species exist.

These fragments consist of a tolerably coarse net-work composed of narrow branches which have the breadth of about 1 to 1½mm. They follow distinctly a zig-zag line, thus meeting each other and diverging again from distance to distance. They augment more or less rapidly in number by the intercalation of new branches, not by the bifurcation of the old ones. The new branches are in the beginning thinner than the old ones. At the junctions of the branches they are quite blended together. These connecting portions are broader than long and as broad or broader than the single branches; they form a kind of indistinct dissepiments. They are situated on the same level as the surface of the branches, and are, like the latter, entirely covered with pores.

The fenestrules are about 1½ to 2mm. long, oval, and always considerably longer than broad. They are very regularly arranged in quincunx, and there are generally four fenestrules in the longitudinal direction within the distance of 10mm. In the obliquely ascending rows, five fenestrules can be counted within the same distance.

On the poriferous side there are irregular tubercles distributed along the branches; they do not however interfere with the distribution of the pores. These pores are arranged in five to six longitudinal alternating rows, and thus are distributed regularly in quincunx. The obliquely ascending rows are also mostly composed of five to six pores.

The non-poriferous side is covered with very numerous and very fine longitudinal striæ which only with difficulty can be distinguished. From distance to distance little root-like prominences occur, which probably have served as a partial support to the colony.

Locality and geological position.—There is a single specimen of this species preserved in the collection. It was found in the Cephalopoda-bed of the upper division of the Productus-limestone of Jabi.

Remarks.—The present species has a rather near ally in the permo-carboniferous beds of Spitzbergen. This is ***Phyllop. laubei***, Toula. The dimensions of the fenestrules as well as those of the branches are very similar in both forms; but Toula mentions only three rows of pores on the branches, whilst there are five to six such rows in ***Phyllop. jabiensis***, and the tubercles with which the poriferous side is ornamented are irregularly distributed in the Indian species, whilst they form a regular row on the middle-line of the branches in ***Phyllop. laubei.***

It is however on the whole not improbable that the ***Phyllop. laubei*** may have been the ancestor of our ***Phyllop. jabiensis***, though the geographical occurrence of the two is so very different.

2. PHYLLOPORA CRIBELLUM, KONINCK, Pl. XCII, figs. 2, 3.

1863. ***Phyllopora cribellum***, Koninck: Quart. Journ. Geol. Soc. Lond., vol. XIX, p. 6, pl. I, fig. 2.
1863. ***Phyllopora ? cribellum***, Koninck: Foss. Paléoz. de l'Inde, p. 19, pl. I, fig. 2.

The colony consists of a thin calcareous plate, having on the whole an infundibuliform shape, with somewhat waving peripheral parts. At its lower extremity the colony terminates in a thick short calcareous stem which is very compact and on which even the fenestrules are partly obliterated.

The remaining part of the colony is pierced by numerous round holes, and neither branches nor dissepiments can be distinguished on the non-poriferous side. This latter is the outer one, whilst the pores are distributed on the inner side of the funnel. The round holes or fenestrules are arranged very distinctly in quincunx, whereby obliquely ascending intersecting rows are formed. Within these oblique rows eight such fenestrules can be counted, in a length of 10mm.

On the poriferous side, on the contrary, the branches can very distinctly be made out. They are about 1mm. broad, anastomosing from distance to distance, but as they are joined together only by their lateral portions, they can be followed out forming waving lines, bending to and fro. The fenestrules, which are produced in this way, are elongately oval or lozenge-shaped and appear rather smaller than on the other side. The branches can also be distinctly seen here to augment by bifurcation and not by intercalation. On this side longitudinal as well as oblique rows of fenestrules can be made out. In the longitudinal rows only six fenestrules can be counted within the distance of 10mm., while in the oblique rows, as on the other side, eight fenestrules occur within the same distance. The cause is, that the parts connecting the branches are broader than the branches themselves and at the same time distinctly excavated, whereby it happens that the branches appear so well separated from each other.

The comparatively large cell-openings are of an oval-shape and do not project above the surface of the branches. The cells themselves are vertical to this same surface. There can be counted four to five longitudinal alternating rows of pores; they cover all the internal face of the funnel-shaped colony without leaving any space free of pores where the branches are joined laterally together.

On the non-poriferous side the fenestrules appear, as has been stated above, as nearly circular holes. The surface of this side is composed of very numerous and exceedingly fine capillary tubes. If the outer coating is entirely well preserved, the whole surface is covered by a fine but very distinct granulation.

The species seems to have attained only a very moderate size. There is one nearly entire specimen preserved in the collection, and its height is not more than about 30mm., while the breadth at the upper end of the funnel can barely have ever been more than 50mm.

Locality and geological position.—There are only two specimens of this species preserved, one of which was found in the Cephalopoda-bed of the upper Productus-limestone at Jabi, while the other comes from the middle region of the middle Productus-limestone of Morah.

Remarks.—The present species was originally described by Koninck only from the non-poriferous side, and thus in looking through the Salt-range materials it was necessary first to find out specimens which would on their non-poriferous side be identical with Mons. de Koninck's drawings and description. This has been secured with the specimens figured by us on Pl. XCII; and it needs only a comparison of these figures with Koninck's drawing to become convinced of the matter. Only afterwards was the poriferous side made visible, and it was found that this side was very unexpectedly similar to a species figured by M'Coy from the carboniferous-limestone of Ireland. This is *Retepora undata*, M'Coy, which in its general appearance and the arrangement of the fenestrules and pores appears very nearly related to *Phyllopora cribellum*, but is distinct from it by its much larger size and less numerous pores.

3. PHYLLOPORA HAIMEANA, KONINCK, Pl. XCV, fig. 1, ? Pl. XCI, fig. 7.

1863. *Phyllopora ? haimeana*, Koninck: Quart. Journ. Geol. Soc. Lond., vol. XIX, p. 6, pl. I, fig. 3.
1863. *Phyllopora jonesiana*, Koninck: Foss. Paléoz. de l'Inde, p. 19, pl. I, fig. 3.

There are apparently no materials at all in the Salt-range collection which can without hesitation be assigned to this species of Mons. de Koninck's. Perhaps the specimen figured by us, Pl. XCI, fig. 7, might be placed in the species, but as the specimen is such a very small fragment and of such a singular hemispherical shape, we could not be sure of the matter.

We shall thus restrict ourselves to reproduce Mons. de Koninck's description of the original specimen and then add a description of the doubtful specimen which may perhaps represent the species in the Salt-range collection.

Mons. de Koninck describes his *Phyllop. haimeana* in the following manner: "The calcareous plate of this species is rather thicker than that of *Phyllop. cribellum*, but its shape is almost the same. The openings, with which it is covered, are much larger; they are circular, and also somewhat funnel-shaped. Their disposition is much less regularly quincuncial; one can count but four or five every centimetre. Only a single specimen is known." To complete this description we have given a copy of Mons. de Koninck's original drawing on Pl. XCV, fig. 1.

It is evident that in the specimen which served for description, the non-poriferous side only was exposed to view. If we compare now our specimen from the Salt-range with Mons. de Koninck's description and figure, we find that though the dimensions are not exactly the same, yet they are very nearly so, and as also the other characters are very similar, we thought it most probable that this small specimen might belong to Koninck's species.

The whole specimen forms a tolerably thick shelly plate which is bent in such a way as to present a hemispherical outline. This plate is pierced by rather numerous circular or slightly oval holes, which are distinctly funnel-shaped on the non-poriferous side. These holes on the non-poriferous side have on an average a diameter of about 1 to 1½mm. while the spaces between are always at least 1½mm. broad. No branches or dissepiments can be distinguished. Of the holes or fenestrules at least five can be counted within a length of 10mm. They are arranged somewhat irregularly in quincunx, and obliquely ascending rows can be made out only with difficulty.

The shelly spaces between the fenestrules are well vaulted and their surface, if looked at with a lens, seems to be provided with many irregular shallow pores or something like pores, probably an effect of weathering.

The poriferous side, which it was very difficult to expose to view, is in its general appearance very similar to the non-poriferous one. The branches are perhaps a little more distinguishable than on the other side. They appear rather broad and bending laterally to and fro, uniting and disuniting again, and thus forming fenestrules of an elongately oval shape, which however appear not much smaller than on the non-poriferous side. Their arrangement is on both sides identical. The branches are covered with numerous cell-openings which are distinctly arranged in quincunx and form about four to five longitudinal alternating rows. On the whole poriferous side there is not the smallest space free from pores. The pores themselves are round and tolerably large; their margins are not raised above the surface of the branches.

As to the size of this species, nothing can be indicated, as only small fragments of the colony have been found up to the present.

Locality and geological position.—The only small fragment that might be assigned to this species was found in the middle division of the Productus-limestone at Morah. From what special locality the specimen described by Mons. de Koninck was procured is not known.

Remarks.—If one takes only Mons. de Koninck's drawing into consideration, then the species has a very peculiar appearance and can be easily distinguished from the other species occurring in the Salt-range. If, however, our fragment may be taken as belonging to *Phyllop. haimeana*, then the species no longer appears to hold such a separate position, but can well be compared to other species chiefly to the *Phyllop. jabiensis* described above.

From this last-named species the present one can be distinguished by fenestrules which appear much rounder, not so oval on the non-poriferous side, and arranged at the same time much less regularly in quincunx. On the poriferous side the branches are devoid of the tubercles which constitute such a characteristic ornamentation of *Phyllop. jabiensis*, and bear also a somewhat smaller number of pores. These characters seem sufficient for the distinction of the two species.

From *Phyllop. laubei*, Toula, which is also related to *Phyllop. jabiensis*, and which thus might also be compared to the present species, the latter can be distinguished by the absence of an ornamentation on the poriferous side of the branches and by more numerous pores, as in the species from Spitzbergen only three longitudinal rows exist.

Phyllop. cribellum, Kon., can easily be distinguished by the much smaller fenestrules and the entirely different poriferous side, in which the branches can easily be made out.

Genus: SYNOCLADIA, King.

This genus is represented in the Salt-range by very numerous individuals, which belong however all to one and the same species.

The genus is always very easily recognisable. It forms generally infundibuliform colonies composed of numerous branches, which take their origin at a small root-like organ, extend nearly parallel to each other and bifurcate at intervals. On both sides of the branches, numerous small branchlets originate, extending obliquely upward and uniting from both sides under an obtuse angle. These angles of the dissepiments are often connected by vertically ascending pieces, forming narrow secondary branches.

The pores are distributed on the internal side of the funnel-shaped colony, and the dissepiments as well as the branches are covered with them. They are arranged in an imbricating manner, and are separated from each other in the longitudinal direction by prominent ridges which sometimes bear secondary pores (the gemmuliferous vesicles of King).

Though this genus is very easily distinguishable from all the other genera of the *Fenestellidæ* yet it has not always been rightly interpreted. Thus, for instance, the form described by Meek under the name of *Synocladia biserialis* seems not to belong to the genus, but must rather be united with the genus *Septopora* of Prout. On account of the genus having sometimes been mistaken, it is difficult to indicate its geographical distribution and geological range.

In America the genus seems, so far as we are aware, not to occur at all. In the eastern hemisphere, on the contrary, it is very plentifully represented, but seems to be restricted to the permian formation, and seems never to have been correctly quoted from carboniferous strata.

As regards species, it must be confessed, that the genus is very poor. Also we are not in a position to add a new species to the one already known, as in the Salt-range only the characteristic permian species *Synocladia virgulacea* occurs.

It has been found not rarely in the middle as well as in the upper division of the Productus-limestone.

1. SYNOCLADIA VIRGULACEA, Phill. sp., Pl. XCII, fig. 4; Pl. XCIII, figs. 1, 2, ? Pl. XC, fig. 8.

1829. *Retepora virgulacea*, Phillips: Trans. Geol. Soc. Lond., 2nd ser., vol III, p. 120, pl. XII, fig. 6.
1834. *Retepora virgulacea*, Phillips: Encycl. Met., vol. VI, p. 615, pl. III, fig. 2.
1845. *Fenestella virgulacea*, (Phill.) Verneuil: Murch. Vern. Kays., Geol. of Russia, p. 221.
1850. *Synocladia virgulacea*, (Phill.) King: Monogr. Brit. Perm. Foss., p. 39, pl. III, fig. 14, pl. IV, figs. 1—8.
1855. *Synocladia virgulacea*, (Phill.) M'Coy: Brit. Palæoz. Foss., 115.
1861. *Synocladia virgulacea*, (Phill.) Geinitz: Dyas, p. 118, pl. XXII, figs. 3, 4.
1863. *Retepora ? lepida*, Koninck: Quart. Journ. Geol. Soc. Lond., Vol. XIX, p. 6, pl. I, fig. 5.
1863. *Retepora ? lepida*, Koninck: Foss. Paléoz. de l'Inde, p. 19, pl. I, fig. 5.

The colony is infundibuliform, often irregularly folded and very variable in respect of the strength of the branches and the shape and size of the fenestrules.

The branches in different specimens, and even in one and the same specimen, are sometimes thicker sometimes thinner, but the difference is not very great. They originate from a thin root, bifurcate frequently, augmenting somewhat in thickness just before the bifurcation takes place, and extend either quite straight and parallel to each other to the periphery of the colony or, in folded specimens, they are slightly curved. They sometimes approach very close to each other, sometimes there is a greater space between them.

The dissepiments are sometimes very short, sometimes rather long, according to the distance between the branches. They are united to the branches under a more or less acute angle, and form in the middle either an obtuse angle or a broad arch. When the distance between the branches is very small, the dissepiments are quite straight. They are always much thinner than the branches, and on both sides of the colony they lie at a lower level than the surface of the branches. In the middle, where the angle is formed, a process often arises and sometimes unites with the next dissepiment, and so on, so that a kind of secondary branches are thus formed. These are always much thinner and situated on a lower level than the main branches, and disappear again after a short distance.

The fenestrules occurring between the branches and the dissepiments are correspondingly variable; sometimes they are large or small; sometimes long and more or less trapezoidal, or short and very broad, or in other cases the shape may be oval or nearly circular, or quite irregularly polygonal. Their margins sometimes appear denticulated. There are in the longitudinal direction nine to eleven fenestrules within a length of 10mm. while in the transverse direction five to seven rows can be counted within the same distance.

The cells are more or less tubular or pyriform, placed obliquely to the axis of the branches, and arranged in an imbricating manner. The cell-openings are round with slightly raised margin. They form three or five alternating longitudinal rows on the branches, separated from each other by slightly raised undulating keels, on the top of which, under favourable circumstances, very small accessory pores, placed alternately with the larger cell-openings, can be distinguished. The cells extend also upon the dissepiments in two to three irregular rows of pores, so that no space remains free of pores.

The non-poriferous side is in general appearance not much different from the poriferous one. Its surface is finely striated longitudinally.

From King's drawings it is known that the species attained rather considerable dimensions. The Indian materials consist of mere fragments of the colonies and do not allow of any conclusion as to the size the entire colonies once attained.

Locality and geological position.—The present species is one of those *Bryozoa* which occur most commonly in the Salt-range; in fact it may be termed the commonest species. It occurs in the middle division as well as in the upper division of the Productus-limestone, and is in both divisions about equally common.

In the middle division it has been found at Morah (2 sp.) at Kàfirkot (1 sp.) and at the Paranga Kass (1 sp.).

In the upper division it has been met with in the lowest beds at Khura (2 sp.) and in the Cephalopoda-bed at Jabi (2 sp.) and at Chidru (2 sp).

Remarks.—It is well known that the present species is one of the most characteristic and most widely spread species of the permian formation. It has been found in the Zechstein of Germany and in the magnesian-limestone of England as well as in the permian beds of Russia.

As regards the determination of our Indian specimens, it seems to us that it needs only a comparison of the figures given by King or Geinitz with those on our plates XCII and XCIII to become convinced of the specific identity. The very slight discrepancies which might perhaps be detected arise certainly only from the mode of preservation of the Indian specimens, which are either in great part silicified, or entirely calcareous, and then often so much weather-worn that the thickness of the branches dwindles down to mere threads.

A specimen preserved in such fashion is that figured by Mons. de Koninck under the name of *Retepora ? lepida.* We are perfectly convinced that the figure given by Mons. de Koninck represents a weather-worn specimen of *Synocladia virgulacea,* and we have accordingly placed Mons. de Koninck's name *Retepora lepida* in the synonymy of the species. As the original of Mons. de Koninck's species has been lost, one can only judge by the figure.

The specimen, figured on pl. XC, fig. 8, is preserved in a rock fragment from Jabi, but we do not exactly know how to determine it. It seems probable that it belongs to the genus *Synocladia,* and it might be considered as a very young colony of *Synocladia virgulacea,* but we are not certain of it. The fragment is too small to express any more definite opinion on it.

The occurrence of this well-known and very characteristic permian species in the Productus-limestone of the Salt-range confirms once more our opinion already expressed, that the middle and upper divisions of the Productus-limestone must be considered as most probably equivalent of the permian formation of Europe.

Sub-family: *GONIOCLADINÆ.*

Genus: GONIOCLADIA, R. Etheridge, jun.

This genus was originally (1873) described by Etheridge under the name of *Carinella,* a name that has been accepted in Zittel's Hand-book. Afterwards however, in the year 1876, Mr. Etheridge found that the name *Carinella* had been previously used for a genus of Annelids, and accordingly he changed it into *Goniocladia.*

The colonies belonging to this genus consist of irregularly bending, anastomosing branches, which form thus a confused net-work. The branches are provided on the poriferous as well as on the non-poriferous side with a strongly prominent median keel, on both sides of which, or the poriferous side, the cell-openings are distributed. The branches seem all to rise from a common root, and augment by indistinct bifurcation. The whole colony seems to have been leaf- or fan-shaped.

By the anastomosis of the branches rather large meshes are produced, which are either of pentagonal or hexagonal or of an irregularly polygonal outline. The keel on both sides of the branches, following every bend of the latter, surrounds the meshes on all sides, and as also the pores are everywhere present on the poriferous side, it becomes impossible to distinguish between branches and dissepiments.

From all these characters it results that the general appearance of the genus becomes most striking, and one which can be distinguished at a first glance from all the rest of the *Fenestellidæ.* It unites, if we may say so, the characters of the *Fenestellinæ* and the *Polyporinæ,* and is distinct from both by the very loose net-work, and the strongly carinated non-poriferous side.

Most nearly related to the present genus seems to be the genus *Ramipora* of Toula, in which the branches are also carinated on both sides. The ramification of

Ramipora is however entirely different from that of *Goniocladia*, and thus the two genera can easily be distinguished.

Of the genus *Goniocladia*, only a single species has up to the present been described, it was found in the carboniferous beds of Carluke. We are able to add another species, which will bear the name of *Goniocladia indica*, W. and P., from the middle division of the Productus-limestone. It thus appears probable that it is of permian age.

1. Goniocladia indica, Waagen and Pichl, Pl. XCIII, fig. 3.

The colony forms fan- or leaf-shaped, flatly folded expansions, composed of an irregular loose net-work.

The branches forming the net-work are frequently and angularly bent, but the way in which they divide and again re-unite is so irregular that it is quite impossible to follow one branch for any distance. For the same reason it is also impossible to distinguish between branches and dissepiments. Sometimes it appears as if a rather irregular dichotomous branching could be made out, but soon the branches are lost again in the general net-work. Sometimes a single branch originates on the broader of one of the meshes and forms a little prominence not again connected with the net-work. The breadth of the branches is about 1½mm. They are strongly compressed laterally, and provided on the poriferous as well as on the non-poriferous side with a high keel, from which on both sides the surface descends rapidly, giving to it a roof-shaped appearance. This keel takes part in all the branchings of the net-work, and appears generally somewhat stronger on the non-poriferous than on the poriferous side. On the former it appears in well preserved specimens as a high edge, which is supported interiorly, as can be seen in weathered places, by a vertical lamella, on both sides of which the cells take their origin. On the poriferous side on the contrary it is mostly more rounded and less prominent, but here also generally a lamella runs along it.

The fenestrules or meshes of the net-work are comparatively large and of very irregular outline, mostly longer than wide. Their length varies from three to seven millimetres while their breadth is from 1 to 4mm. They are either lozenge-shaped or pentagonal, hexagonal or else irregularly polygonal. Their margins are sometimes slightly indented by the projecting cell-apertures; sometimes however they are quite smooth.

The pores or cell-apertures are distributed on the poriferous side on both sides of the median keel. They are round with slightly projecting margins and form on each side of the keel three alternating rows, the lowest of which is placed very far towards the non-poriferous side. The whole obverse side of the colony is occupied by these pores, and they are to be found on the branches as well as on the places where the branches unite.

The non-poriferous side is occupied by a very thin basal-plate, which, if well preserved, shows a fine longitudinal striation. This is however very easily lost, and even the basal-plate itself, on account of its thinness, is easily destroyed, and then the origin of the cells on both sides of a median lamella can be well observed (Pl. XCIII, fig. 3e.).

The single specimen preserved in the Salt-range collection does not allow any conclusion as to the size the entire colony may have attained.

Locality and geological position.—There is a single specimen of this species preserved in the Salt-range collection. It was found at Káfirkot in the middle region of the middle division of the Productus-limestone.

Remarks.—As only a single species of *Goniocladia* has up to the present been described, it needs but a comparison of the Indian fossil with this species to judge of its specific affinities. It cannot be denied that the Indian specimen shows great similarity to *Goniocl. cellulifera*, Eth., and for a long time we were very much in doubt whether the two forms should not be united, but after a lengthened consideration we came to the conclusion that the Indian fossil belonged probably to a different species. The chief difference seems to consist in the mode of ramification; in the European species the branches can be followed to some extent while this is quite impossible in the species here under description. Also the branches are somewhat thicker and the fenestrules larger, and the keel on the non-poriferous side stronger in our *Goniocladia indica*. Since these differences occur in fossils so very far removed from each other, geographically as well as geologically, it seemed to us highly probable that the Indian fossil belonged to a different species from the European one, and we accordingly have introduced a new name for it.

Family: THAMNISCIDÆ.

This family was created by Mr. King to receive certain arborescent colonies of *Bryozoa*, the branches of which are all about in one plane, and the cell-openings occur only on one side of the branches. The genus *Thamniscus*, King, had been taken as the type of the family.

Though Mr. Zittel in his Hand-book accepts nearly the same groupment of the genera as proposed by King, yet he could not retain the name *Thamniscidæ*, as he considered *Thamniscus* identical with *Acanthocladia*, and therefore changed the name into *Acanthocladidæ*.

We cannot agree in this respect with Prof. Zittel, not only because the name *Thamniscidæ* is the older one, but also because it seems to us that the genus *Thamniscus* can very well be kept separate from *Acanthocladia*, and thus entirely disappears the reason on account of which the name was changed by Zittel. We therefore accept King's name for the family.

There is barely anything to be added to King's excellent characteristic of the family. The *Bryozoa* belonging to it form arborescent colonies, which consist of one or several primary branches, from which on both sides secondary branches take their origin; these however always remain free and are never connected by dissepiments or otherwise as is the case in the family *Fenestellidæ*. All these branches are situated in one plane.

The internal structure is similar to that of the *Fenestellidæ*. The cells take their origin at the basal-plate, which occupies the non-poriferous side of the colony; thence they ascend, arranged in an imbricating manner, and their openings are to be found on the poriferous side, where they form two or more longitudinal rows of pores.

The number of genera belonging to this family is not very large, nevertheless it might be possible to distinguish sub-families, as has been done in the family *Fenestellidæ*. The materials in our hands are however too scanty to express a definite opinion in this respect, and we must leave the solution of this question to later observers.

Zittel in his Hand-book quotes in the present family the genera *Acanthocladia*, King, *Pseudohornera*, F. Roem, *Penniretepora*, Orb. (= *Glauconome*, Lonsd.) and *Ichthyorhachis*, M. Coy. To these must be added *Thamniscus*, King, which has been united by Zittel with *Acanthocladia*.

In the Salt-range the two genera *Thamniscus* and *Acanthocladia* are represented, the former by two and the latter by one species.

Genus: THAMNISCUS, King.

The genus was founded upon the comparatively large and robust *Thamn. dubius* from the permian beds of Europe, and only such forms as agree in all respects with this permian fossil should be united with the genus.

A characteristic of the genus from this typical permian species is as follows: The colony is composed of numerous comparatively stout branches, which frequently bifurcate, the bifurcation being always terminal and mostly unilateral, so that only one of the newly-formed branches (nearly always directed towards the same side) goes on augmenting in size and again bifurcating. All the branches are approximately in one plane, and all are of about equal strength. The branches are covered with cell-openings only on one side, the other side is non-poriferous. The cell-openings are arranged more or less regularly in quincunx, and between them sometimes so called gemmuliferous vesicles are distributed.

According to King and Geinitz an anastomosis of the branchlets may sometimes occur, so as to form fenestrules similar to those occurring in Synocladia. The occurrence of such fenestrules has however been doubted recently by Shrubsole, and we must confess that we also have not been able to observe such an anastomosis in the specimens at our disposal.

The character which distinguishes the present genus from the other allied ones consists then in the quite peculiar ramification, which is irregularly terminal, dichotomous, and mostly one-sided.

The distinctness of the genus has however not been always recognised. Zittel in his Hand-book unites it with *Acanthocladia*. This is evidently a mistake caused by the misapprehension that the distinction of *Thamniscus* and *Acanthocladia* was founded upon the arrangement of the pores, which is said to be quincuncial in the one case and in rows in the other. From what has been said above however, it appears that the distinction of the two genera rests chiefly in the ramification of the whole colony, which is so very different in the two cases that a distinction becomes most easy.

The genus has its geological distribution chiefly in the permian formation, where the typical species was found. More recently species have also been quoted from carboniferous as well as from silurian formations. For the silurian forms however, which were originally quoted by Lonsdale under the generic designation of *Hornera*, the name of *Pseudohornera* has been introduced by F. Roemer. This *Pseudohornera* is distinct from *Thamniscus* by the much thinner branches, which bifurcate less frequently and more regularly than in *Thamniscus*, and show rather a bilateral than a unilateral branching. If then the silurian species must be considered as belonging very probably to a different genus, it is so also with the carboniferous *Thamniscus rankini*, Young, which differs by the same characters from *Thamniscus* as the silurian *Pseudohornera crassa*, Lonsd. Thus only the permian *Thamniscus dubius* would remain in the genus, and the genus would be restricted to the permian formation, unless *Thamniscus bifidus*, Eichw. makes an exception, as it is said to be from the silurian Orthoceras-limestone. It is however well known how little the stratigraphical indications in Eichwald's work can be trusted.

In the Salt-range the genus is represented by two highly interesting species. One of them can be directly identified with the permian *Thamniscus dubius* and is thus of much geological interest; the other is a large species with regularly arranged cell-apertures; it augments by one the number of permian species of *Thamniscus*.

Both these Salt-range species occur in the middle division of the Productus-limestone, the latter however extends also into the upper division.

THAMNISCUS DUBIUS, Schloth, sp., Pl. XCIII. fig. 4.

1820. *Keratophytes dubius*, Schlotheim: Petrefaktenkunde, p. 340.
1826. *Gorgonia dubia* (Schloth. sp.) Goldfuss: Petref. Germ., Vol. I, p. 18, pl. 7, fig. 1.
1844. *Fenestella ramosa et dubia*, King: Bull. Soc. Geol. de France, I, p. 24, 25.
1850. *Thamniscus dubius* (Schloth. sp.) King: Monogr. Brit. Perm. Foss., p. 44, pl. 5, fig. 7—12.
1850. *Penniretepora dubia* (Schloth. sp.) d'Orbigny: Prodr. de Pal. strat., I, p. 169 (pars).
1853. *Thamniscus dubius* (Schloth.) Schauroth: Sitzgsber. Acad. d. W. Wien, Vol. XI, p. 184. fig. 23.
1858. *Thamniscus dubius* (Schloth.) Swallow and Hawn: The rocks of Kansas; Trans. St. Louis Acad. of Sci., Vol. I, Nr. 2, p. 179.
1861. *Acanthocladia dubia* (Schloth.) Geinitz: Dyas, p. 119, pl. XXII, fig. 5, 6.
1882. *Thamniscus dubius* (Schloth.) Shrubsole: Quart. Journ. Geol. Soc. Lond., Vol. XXXVIII, p. 343.

We have given in the above list only some of the quotations which seemed to us of importance for the right understanding of the specific characters. The full list of synonyms is to be found in Geinitz's Dyas.

The colony forms arborescent expansions made up of numerous branches having an average thickness of 1 to 1½mm. These branches bifurcate frequently and irregularly in such a manner that the lateral branches are of the same strength as the primary ones, and are directed almost all to one and the same side. Both surfaces of the branches are flatly vaulted.

The cell-openings are all to be found on one side only of the branches. They form little round pores, the margins of which are somewhat raised, and rather far distant from each other, leaving a distance between them which is often nearly twice as large as the pores themselves. When the surface of the branches is more or less weathered, the pores appear much larger, much closer together, and more or less lozenge-shaped.

The arrangement of the pores is generally more or less regularly in quincunx, in three to six alternating longitudinal rows. Gemmuliferous vesicles, as they have been called by King, have not been observed in the Indian specimens.

The non-poriferous side is apparently smooth.

From the somewhat fragmentary specimens of the Salt-range, nothing can be judged as to the size the species may have attained, and it would seem from European specimens that the size was never very considerable.

Locality and geological position.—There are altogether only two not very extensive fragments of this species preserved in the Salt-range collection, which are both contained in a slab of rusty-coloured limestone, collected by Mr. Wynne at Morah in the middle region of the middle Productus-limestone. On the same slab specimens of *Phyllopora cribellum* Kon. and *Acanthocladia anceps* Schl. are to be observed.

Remarks.—The specimens from the Salt-range that have served us for description of the species are on the whole not very well preserved, as the greater part of the surface is much deteriorated by weathering. Yet there is sufficient to allow of an exact determination, whereby we can safely identify the Indian specimens with *Thamniscus dubius*, Schloth.

The ramification of the branches is about the same, though in these not very extensive fragments this can only be judged on a small scale. The thickness of the branches and the distribution of the pores on the well preserved parts of the surface are absolutely identical, and on the whole it seems to us impossible to determine these fragments otherwise than as *Thamniscus dubius*, Schloth. Large specimens however will have to be discovered before every doubt with regard to this species can be removed.

Nevertheless the correctness of our determination is highly probable, and the geological importance of the occurrence of a species not distinguishable from *Thamniscus dubius* in the Productus-limestone of the Salt-range is not much altered by the fact that only comparatively small fragments have been found up to the present, as it is highly probable that large specimens will also agree with the European permian species.

The occurrence of this species on the same slab with *Acanthocladia anceps*, Schloth., another permian species that will be described in the following pages, gives so much the more value to the determination of *Thamniscus dubius*. The list of permian fossils occurring in the Salt-range, which is already rather considerable, is thus augmented by one.

Thamniscus dubius is one of the most characteristic and most wide-spread species of the permian formation. It has not only been found in the "Zechstien" of Central Europe, but also most commonly in the permian beds of the British Isles, and in the same beds at Cotton-wood Creek in Kansas. Since the detection of the Indian localities it would seem that the species spread over the whole world.

2. THAMNISCUS SERIALIS, Waagen and Piehl, n. sp., Pl. XCIV, fig. 4, 5, 6.

The colony forms arborescent flattened expansions composed of numerous ramifying branches. These are generally about 2mm. in width, with the surface flatly vaulted; they bifurcate frequently, at intervals of about 5 to 10mm. The lateral branches thus formed are about of the same strength as the principal stems; they are mostly all directed towards the same side, and bend quickly upward, following about the same direction as the principal stems. Just before the bifurcation takes place the stems are generally somewhat thickened.

The numerous tubular cells, occupying nearly the whole breadth of the branches, ascend obliquely and are arranged in an imbricating manner. The openings have strongly raised margins, especially those having more a lateral direction project far above the surface of the branches. Several of these cell-openings are joined together laterally and thus form ridges starting from the median parts of the branches and extending in an oblique direction towards the margins; the pores are situated along the top of these ridges. The very characteristic sculpturing thus produced is not however connected with any structural peculiarity as can be seen in weathered specimens in which those oblique ridges disappear. In such specimens the pores form seven alternating longitudinal rows, whereby a distinct quincuncial arrangement is produced, so that oblique intersecting rows of pores are as easily distinguishable as in any *Polypora*. On unweathered parts of the branches, only the three median longitudinal rows of pores can distinctly and easily be made out as in a quincuncial position.

The non-poriferous side is occupied by a very thick stony basal-plate. It is very indistinctly striated longitudinally, almost smooth, and pierced at intervals by very small pores.

The species seems to have attained rather considerable dimensions, and to have varied slightly according to age; at least we notice that some of the specimens at our disposal branch more frequently than others. It is probable that the former represent the lower or older parts of the colony.

Locality and geological position.—There are altogether three specimens of this species in the Salt-range collection. The one most beautifully preserved was found by Mr. Wynne, at Morah, in the middle region of the middle Productus-limestone. It forms a rather large arborescent expansion, in which the singular ramification of the species can be well studied. The other two specimens are smaller fragments and were both collected at Khura in the lower beds of the upper Productus-limestone.

Remarks.—The present species has in its outward appearance a certain similarity to *Idmonea*, and we for a time thought that it should perhaps be placed in that genus; but after a careful examination of our specimens, we found that they had in reality much more affinity to *Thamniscus* than to *Idmonea* as the bilateral sculpturing of the branches is only an external feature and not caused by a peculiar arrangement of the cells, and as the median dividing edge characteristic of *Idmonea* is altogether wanting. After having thus settled the generic relations there remained no doubt that the specific characters were very peculiar, making a distinction from all the other species of *Thamniscus* hitherto described most easy. There is a single species with a similar number of longitudinal rows of pores and similarly robust branches, and this is *Thamniscus bifidus*, Eichw. This species is quoted by Eichwald as coming from the silurian *Orthoceras*-limestone of Russia, but it seems to represent a true *Thamniscus.* From what has been said in the introduction to the genus it might perhaps be doubted whether this species really came from those beds, as in silurian strata the genus *Thamniscus* seems to be generally absent and to be replaced by the genus *Pseudohornera*, Roem. However this may be, the species *Thamn. bifidus* can only with difficulty be compared to our *Thamniscus serialis*, as of the former only the non-poriferous side is figured, and of the poriferous side nothing is stated but that about seven longitudinal rows of pores can be counted.

The evidence before us is much against the probability of the two species being identical, and thus we have ventured to introduce a new name for the Indian form.

Genus: ACANTHOCLADIA, King.

The genus *Acanthocladia* is made up of a very small number of species, of which the permian *Acanthocladia anceps* is the most common and at the same time the best known.

It has already been stated that this genus has sometimes been united with *Thamniscus*, King. As this proceeding is however entirely erroneous, it may not be superfluous here again to repeat the generic diagnosis of *Acanthocladia.*

The colony is arborescent, composed of a few not frequently dividing branches, which all extend in about one and the same plane. The principal branches of the colony are mostly rather straight, and show from distance to distance a usually terminal bifurcation in which the two newly formed branches deviate equally from the original direction of the branch, or the principal branch remains in its original direction and a lateral branch sets off from it.

All the principal stems of which the colony is thus composed are furnished on both sides with little branchlets which are much narrower than the principal stems, and never attain a very considerable length. They are about parallel with each other, always quite free, never joined together, and give to the principal stems a pinnate appearance. Their position is mostly alternating on the two sides, and they are generally of about equal thickness for their whole length and truncated at the extremity.

One side only of the colony is poriferous, and on this side the pores cover the lateral branchlets as well as the principal stems. The pores form mostly alternating longitudinal rows, which are more or less distinct. Often, it seems, the rows are separated from each other by longitudinal ridges on which very small pores (the gemmuliferous vesicles of King) are situated.

The non-poriferous side is for the most part finely striated longitudinally.

From this description it already most clearly appears that the chief difference between *Acanthocladia* and *Thamniscus* consists in the modes of ramification. In *Thamniscus* there is no distinction between stems and branchlets, as all the branches are of about equal thickness and are produced by bifurcation. In *Acanthocladia*, on the contrary, only the principal stems can be compared to the branches of *Thamniscus*, while the branchlets are organs which are restricted to the genus *Acanthocladia* and do not occur in *Thamniscus*. This occurrence of branchlets by which the stems acquire a pinnate appearance is a very peculiar character and makes the distinction of the two genera not only easy but absolutely necessary.

In the Salt-range we have found only a single species of *Acanthocladia*, which is however so much the more interesting as it can be identified with the permian *Acanthocladia anceps*, Schloth.

It was found in the middle region of the middle Productus-limestone.

ACANTHOCLADIA ANCEPS, Schloth., sp., Pl. XCIV, figs. 1, 2, 3.

1820. *Keratophytes anceps*, Schlotheim: Petrefaktenkunde, p. 341.
1826. *Gorgonia anceps* (Schloth.) Goldfuss: Petref. germ., I, p. 98, pl. 36, fig. 1.
1842. *Eschara philippii*, Althaus: Münster's Beitr., V, p. 52.
1848. *Fenestella anceps* (Schloth.) Geinitz: Deutsch. Zechst, p. 18, pl. 7, figs. 19-23.
1850. *Acanthocladia anceps* (Schloth.) King: Monogr. Brit. Perm. Foss., p. 48, pl. 5, figs. 13-18.
1850. *Penniretepora geinitzi*, Ichthyorachis anceps and Ichthyorachis Geinitzi, D'Orbigny: Prodrome, I, p. 169.
1851. *Acanthocladia anceps* (Schloth.) Grünewaldt: De petref. form. calc. cupr., pp. 36, 45.
1861. *Acanthocladia anceps* (Schloth.) Geinitz: Dyas, p. 119, pl. XXII, figs. 7-8.
1881. *Acanthocladia anceps* (Schloth.) Quenstedt: Petrefaktenk. Deutschlands, vol. IV, p. 163, pl. 149, figs. 26-27.

The colony is composed of several slender erect branches, which rise from a common root and bifurcate frequently in the vicinity of this root, while further on the bifurcation takes place only rarely and at great distances. The branches are considerably thicker near the base than further on; at the root the thickness can be estimated at a little less than two millimetres while further on it is on an average 1 to 1½mm.

These principal branches or stems send off on both sides little branchlets, which are only about half the thickness of the stems, remain generally short, are but little tapering, and truncated at their extremity. They are situated either opposite or alternating along the sides of the stems and remain nearly always simple, only in rare cases sending off lateral branchlets. Their number and distance from each other is rather variable; there can be counted from five to ten within a length of 10mm. Generally they are directed somewhat towards the front, forming more or less acute angles with the principal stem. Sometimes however they are placed nearly at right angles with the principal stems. These branchlets give a distinctly pinnate aspect to the whole colony.

The surface of the stems is flatly vaulted on both sides, and bears on one side the comparatively small cell-openings. These form round pores with slightly projecting margins; they are arranged generally in three alternating longitudinal rows, but in exceptional cases up to six such rows may occur. As the rows alternate, the pores show also a more or less regular quincuncial arrangement. In well preserved specimens there extend between the longitudinal rows low strips on which very small pores are distributed. These must very likely be taken to represent the gemmuliferous vesicles of King.

The non-poriferous side is either smooth or shows a very fine longitudinal striation.

The species seems to have attained rather considerable dimensions, as branches of about 30mm. length are not rare. The maximum size may have been about 100mm.

Locality and geological position.—There are several more or less extensive fragments of this species in the Salt-range collection, all occurring on one slab of rusty brown limestone, which contains also the specimens of ***Thamniscus dubius***, Schl., and ***Phyllopora cribellum***, Kon., described above. The slab was collected by Mr. Wynne at Morah in the middle region of the middle Productus-limestone.

Remarks.—Though the fragments of this species are not very extensive and their preservation is not excellent, yet it seems to us that they can safely be identified with Schlotheim's species. The fragments are all from rather low down in the colony, especially the fragment represented in fig. 2 Pl. XCIV, which is broken just above the root. This may quite suffice to explain the slightly more robust condition of the Indian specimens and the somewhat more irregular ramification than is generally observed in European specimens of the species. That the species is rather variable in Europe also is sufficiently shown by King's drawings. The Indian specimens hold about a medium between figs. 13 and 14 on King's pl. V. On the whole, we think, the determination of these fossils as ***Acanthocladia anceps***, Schl., cannot be subject to much doubt.

The species is one of the most characteristic and most wide-spread of the permian formation. In Central Europe it occurs sparingly already in the "Kupferschiefer," and is very common in the Zechstein, quite as common is it too in the Magnesian-limestone of England. From the permian beds of Russia it has also been quoted, and in America either the same species occurs in the permian strata of Kansas, or it is represented there by a very nearly related form which has received from Swallow the name of *Acanthocladia americana*. It is very difficult to judge of this latter form, as neither a figure nor an exact description exists. From the few remarks made by Swallow, it seems to us very doubtful whether *Acanth. americana* can be distinguished from *Acanth. anceps*.

The occurrence of the permian form in the Salt-range is again of much geological importance, and confirms once more the opinion expressed already that the middle and upper divisions of the Productus-limestone must be placed in the permian formation.

Sub-Kingdom: **VERMES.**

Class: ANNELIDA.

Order: CHÆTOPODA.

Sub-Order: TUBICOLA.

Family: ?

Genus: SPIRORBIS, Daudin.

Though the *Annelida* in general present not much interest to the palæontologist, yet they cannot be altogether neglected; they sometimes contribute evidence towards the solution of geological questions.

The genus *Spirorbis* is one of those which have to a certain extent a geological value, as its distribution is very peculiar. Species belonging to the genus are remarkably numerous in palæozoic formations, while they are nearly entirely absent in mesozoic ones, though the genus appears in great numbers again in the recent period. So far the appearance of the genus in great numbers can be considered as of a certain geological value. On the other hand however it must not be forgotten that the determination of worm-like animals from their shells alone is rather precarious; it might very well be the case that the *Spirorbis*-like shells of the palæozoic epoch were inhabited by animals deviating very much from those which now-a-days dwell in such shells. As however the animals of the palæozoic era will never be known to us, we must make the best of it, and must distinguish the shells as far as they are distinguishable.

Thus taking the characters of the shell only, we can describe the genus *Spirorbis* as consisting of small calcareous worm-tubes, spirally coiled, and fixed by the entire under-surface to foreign bodies, only the last whorl becomes sometimes slightly elevated. The spiral is indiscriminately coiled to the right or to the left, and on the upper side usually provided with a more or less wide umbilicus. The surface of the shell is often more or less richly ornamented, but mostly entirely smooth.

The genus is numerously represented throughout the palæozoic formations, but the distinction of species is not easy, as all the forms not provided with a characteristic ornamentation are more or less alike.

In the Salt-range small specimens of *Spirorbis* occur occasionally fixed to the shells of Brachiopods, Corals, or the like, but they are not very numerous. I can distinguish only one species which shows a close resemblance to a form described by King, from the permian beds of the Humbleton Hill under the name of *Spirorbis helix*, and I think I am not mistaken in identifying the Indian specimens with that species.

1. SPIRORBIS HELIX, King, Pl. XCV, figs. 2, 3.

1848. *Spirorbis helix*, King: Catalog., p. 6.
1848. *Spirorbis globosus*, (M'Coy) Howse: T. N. F. C., Vol. I., p. 258.
1850. *Spirorbis helix*, King: Monogr. Brit. Perm. Foss., p. 54, pl. vi, fig. 8.
1861. *Serpula planorbites* (Münst.) Geinitz: Dyas, p. 40 (quotation from King).

These very small shells are of an elevated obtusely conical general shape, with a very small slightly impressed umbilicus on top, and a not very broad base, by which they are fixed to foreign bodies.

The whorls are rounded, somewhat crescent-shaped in their transverse section, almost entirely overlapping each other, so that within the very small point-like umbilicus nothing of the inner volutions can be seen.

The surface of the volutions is smooth and even striæ of growth can be distinguished with difficulty.

The aperture is crescent-shaped, with a well-rounded outer margin or lip, a flat straight lower margin, corresponding to the base, and a concave inner margin, as determined by contact with the preceding whorl.

The substance of the shell is tolerably solid.

The dimensions of these fossils are so very small, that it is barely possible to give measurements. They may best be seen from the drawings on Pl. XCV.

Locality and geological position.—It is not possible for me to give exact numerical indications as to the occurrence of this species in the different divisions of the Productus-limestone, as specimens of it adhere to the most various bodies, and it is impossible to look through all these in search of such minute objects. About half a dozen of them have come to my notice, chiefly adhering to Brachiopods and Corals. They occur in the middle division of the Productus-limestone as well as in the upper division, but have not yet been observed by me in the lower division.

In the middle division I have observed specimens adhering to specimens of *Spirigerella grandis*, W., from Musakheyl and to *Spirigerella derbyi*, W., from Kálabágh. In the upper division the species has been observed by me adhering to specimens of

Streptorhynchus pectiniformis, Dav., and *Derbyia grandis*, W., in the Cephalopoda-bed of Jabi.

Remarks.—This species is very nearly related to *Spirorbis globosus* of the mountain-limestone which has a similarly elevated conical form, but they are distinguishable by the much smaller umbilicus of the Indian fossil.

By Geinitz the present species has been united to *Serpula planorbites*, but I think King's species should be kept separate, as *Serp. planorbites* is a flat widely umbilicated shell, much larger than *Spirorb. helix* and in every respect quite different.

Spirorbis helix is a species of the European permian formation and its occurrence in the Salt-range is thus not without interest.

Genus: SERPULITES, Murchison.

This genus is very easily recognisable on account of its smooth shell, which has a very singular appearance, and in fragments can only with difficulty be distinguished from fish bones or scales.

The shell forms a very long and comparatively thick tube presenting on the whole a rather equal gentle curve, and it may attain the length of a foot and more, so that only more or less extensive fragments of these tubes are commonly found, it being very rare to get a tolerably complete specimen. The shell itself seems to have been somewhat flexible; it is generally compressed without being quite broken. The surface of the shell was apparently shining, either entirely smooth, or provided with wrinkles, tubercles, or the like. The shell-substance is very distinctly composed of several layers, which seem however not to possess very different structures. The shell is always, for the most part, of a dark brown colour, but at the same time there are also many places on which the ashy blue colour of vivianite can be observed. On the whole, in appearance the shell-substance of *Serpulites* very nearly approaches that of the shells of *Lingula*, *Obolus*, and similar *Brachiopoda* which possess a shell composed partly of a horny substance and partly of phosphate of lime, and it seems to me highly probable that the shell of *Serpulites* was of a similar composition. The partial flexibility of this shell makes the presence of a horny substance in it highly probable, as the formation of vivianite in the shell substance proves the presence of phosphorus.

The systematic position of the genus is very doubtful. That this singular shell formed the abode of some worm-like animal cannot be questioned, but beyond this it is very difficult to make any guess. As far as I am aware of, there is no living worm that secretes phosphate of lime in its shell, though there are several that form horny tubes. But all this is of no avail, as among the worms but very little can be inferred as to the nature of the animal from that of the tube which it inhabits. The position of the genus in the class of the *Annelida* must thus be considered as rather arbitrary.

The genus *Serpulites* has chiefly a palæozoic distribution, and apparently its chief development was in the silurian period. In the carboniferous period there were still several species, but in the overlying permian formation the existence of the genus has not as yet been recorded.

In the Salt-range a single species occurs which is restricted to the lower division of the Productus-limestone.

1. SERPULITES INDICUS, Waagen, n. sp.; Pl. XCV, fig. 4.

This is a very large species, and when complete, it must have been of great length. As however only a fragment of it is known, it is impossible for me to indicate to what size the species may have grown.

The fragment that serves for description is entirely compressed, and shows at the same time a flat very equal curve. Its original transverse section must have been circular, but in its present state of preservation the two lateral parts are almost in contact.

The substance of the shell is thin, more or less membranaceous or horny, and must have been soft and flexible, as notwithstanding the great compression it has undergone, it is nowhere distinctly broken, but bent in and out in narrow curves, which can only be explained by supposing that the shell was originally flexible.

The surface of the shell is entirely smooth; even with a powerful lens no striæ of growth can be observed. Owing however to the great compression the shell has undergone, it is covered everywhere with irregular transverse wrinkles.

The shell is shining, of a dark brown colour, changing in places into the ashy blue tint of vivianite; it is composed of many thin lamellæ which easily separate from each other.

The fragment has a length of about 115mm. with a breadth of 20mm. at one end, and 18mm. at the other. There is no aperture at either end of this fragment, so that it must belong to some middle part of the shell. According to these data the entire shell must have attained a length of nearly one metre.

Locality and geological position.—The only fragment of this species that exists in the Salt-range collection was found by Mr. Wynne at Chidru, in the dark sandy limestones, weathering of a rusty brown, composing there the lower division of the Productus-limestone.

Remarks.—It is chiefly to *Serpulites membranaceus*, M'Coy, that the present species may be compared, as the substance of the shell in the two seems rather similar. The Indian species can however be distinguished from the European one by the absence of the thickened parts on both sides of the shell, and by the much larger size. The Indian shell seems indeed to be the largest hitherto made known within the genus.

Of the group of forms without lateral thickenings, to which the present species belongs, none is known above the silurian period. It is therefore of some interest to see this division of the genus re-appear in strata so comparatively new as the lower division of the Productus-limestone.

Sub-Kingdom: **ECHINODERMATA.**

Class: ECHINOIDEA.

Sub-class: PALECHINOIDEA.

Order: PERISCHOECHINIDÆ.

Family: *ARCHÆOCIDARIDÆ.*

Genus: EOCIDARIS, Desor.

The only remains of this genus in the Salt-range collection are some interambulacral plates and a number of spines.

Though these materials are very scanty, they might still possibly serve to elucidate the systematic position of the genus, which has been made somewhat doubtful by Quenstedt.

Quenstedt in his "Petrefactenkunde Deutschlands" admits only the carboniferous species in the genus *Eocidaris*, while he brings the permian forms into closer connection with *Cidaris grandæva*, Gdf., of the Muschelkalk, and with *Cidaris* proper. When however Geinitz in the "Dyas" expressly writes:—"The form of the interambulacral plates is distinctly hexagonal," I cannot see any reason why the permian form should be excluded from the genus. I even think that Quenstedt himself figures quite distinctly hexagonal interambulacral plates even of *Cidaris grandæva* (Petrefk. Deutschl., Vol. III, Pl. LXVII, fig. 3), and thus perhaps this species also had better be transferred to *Eocidaris*.

The forms that have been mentioned are all very small. *Eocidaris rossica*, Buch, which occurs plentifully in the upper carboniferous limestone of Mjatshkowa is much larger. The plates of this species seem however to be nearly always much deteriorated, so that even the crenulated margin round the tubercle is mostly obliterated, and the exact outline and nature of the margins of the plates can rarely be well observed.

This latter point can be well seen in the specimens from the Salt-range, which however belong to a different species. The margins of the plates are vertically cut only on two sides, while the remaining margins are obliquely beveled, thus indicating that the plates were only partially joined together firmly, while in other directions they were probably partly overlapping, and moveable to a certain extent. The shape of the plates cannot be very exactly determined, as one half of them are always broken. The sculpturing however exactly corresponds to that generally occurring in *Eocidaris*.

Now though these plates are gigantic in comparison with their congeners in the permian formation of Europe, yet their position in the genus cannot well be doubted. In this case however the genus *Eocidaris* cannot possibly be placed otherwise than in the family *Archæocidaridæ*, as in this family only do moveable interambulacral plates occur.

In the Salt-range, fragments of the test as well as spines of this genus are not rare, but they are always in such a disunited state, that it is often difficult to decide what may belong to one and the same individual or species. The spines chiefly show very varying forms. Sometimes they are rather large, thickly fusiform and bear very coarse regularly arranged granulations, sometimes they are much smaller and provided with a very fine irregular granulation. But these different shapes are always found together, and I do not think that different species are indicated by them. Thus there would be only one species of the genus in the Salt-range, and this has already long since received the name of *Cidaris forbesiana* from Mons. de Koninck.

1. EOCIDARIS FORBESIANA, Koninck., sp. Pl. XCV, fig. 5-16.

1863. *Cidaris forbesiana*, Koninck: Quart. Journ. Geol. Soc. Lond., Vol. XIX, p. 4, pl. IV, figs. 1-2.
1863. *Cidaris forbesiana*, Koninck: Fossiles paléozoiques de l' Inde, p. 22, pl. III, figs. 1-2.

The species was founded by Mons. de Koninck on a number of isolated spines brought from India by Dr. Fleming.

The spines are not rare in the Salt-range; isolated plates of the body are however much rarer. Nevertheless, wherever I found plates the spines were not far off, and thus it becomes highly probable that spines as well as plates belong to one and the same species.

To begin with the plates, they are large, nearly quite flat, showing only a slight curvature in either direction. Their general shape is very irregular, but the greater number of them have a more or less octagonal outline, while only rarely a plate is found with a hexagonal or pentagonal contour. In the octagonal plates, the upper and lower margins are mostly the longest, and next in length come the margins to the right and left, while the corners of the somewhat irregular quadrangle thus formed are irregularly cut off, whereby the remaining four sides of the octagon are supplied. In the hexagonal or pentagonal plates one of the lateral margins is longest, and joined to the upper and lower margins under approximately right angles; the other margins are formed either by a very short lateral margin and correspondingly long edges cutting off the angles, or these oblique edges may extend so far that the lateral margin entirely disappears, and then a pentagonal plate is produced.

Of all these margins mostly only those directed towards the upper (?) and lateral sides are cut vertically, while the others are obliquely beveled, so that the outer contour of the plate remains untouched. Thus probably the plates rested partly on each other like scales.

The surface of the plates is very characteristically ornamented. Each plate bears in the middle a very large primary tubercle, supported by a high elevated neck, furnished on its upper edge with a deeply crenulated collar. The tubercle itself is nearly always broken away, but the crenulated collar is so much the better exposed. In the depth of the cavity which had been occupied by the tubercle, a rather large foramen is observable, pointing to the perforated nature of the tubercles. Round this very thick and large central primary tubercle a rather large smooth scrobicule of a somewhat transversely oval general outline is developed. This is again surrounded by a very narrow scrobicular margin, which is however nowhere interrupted and bears a single row of not numerous, rather large, distant secondary tubercles.

The radiols have been described already by Mons. de Koninck, and are that part of the animal upon which the species has been founded. They are however apparently very variable in shape and ornamentation, and I must describe the different shapes separately.

The shape originally described by Mons. de Koninck, and which must be considered as the typical one, occurring at the same time most frequently, is thickly fusiform, not quite distinctly pointed, but mostly with a somewhat blunt or more or less truncated extremity. The spines are generally rather flattened on one side and thus acquire a more or less triangular transverse section. Towards the articulating extremity the spines are distinctly tapering, whereby a tolerably long distinct but never very thin neck is produced. The head is thick, provided with a strongly prominent ring. The articulating facet is comparatively small, rather deeply sunk in, perforated in the middle, and surrounded by a prominent strongly crenulated margin.

Another shape that is to be found often on the same slab as the preceding one, is long and bacillary. These spines are thin, not more than 2 to 3 millimetres in thickness, and comparatively very long. They are but very little or not at all tapering towards the head, and thus the neck is only distinguishable by the smoothness of its surface. The stalk is also of a somewhat triangular section, a little flattened on one side, and is provided with a fine longitudinal ribbing, on which fine granules are placed. The head is not very thick, is provided with a but very slightly prominent ring, and bears at its extremity a small articulating facet surrounded by a crenulated circle.

The third shape comprises spines of a much smaller size, which were probably attached to secondary tubercles. They are fusiform, tapering at both ends and not very thick. The surface of these spines is almost smooth, only provided with a very slight irregular granulation exhibiting somewhat the appearance of chagrin leather. The section is circular or somewhat elliptical but not triangular. At one end of the spine the surface becomes entirely smooth whereby a sort of neck is produced. Any head is however entirely absent, as well as the ring which would surround it. The spine is simply terminated at one end by a small hollowed-out articulating facet. It cannot be exactly determined whether this facet was granulated or not.

The materials of this species at hand are not sufficiently well preserved to give any measurements. The dimensions of the single parts can best be seen from the drawings on Pl. XCV.

Locality and geological position.—The present species is entirely restricted to the solid limestones, impregnated with silica, composing the middle region of the middle division of the Productus-limestone. Thus the spines as well as the interambulacral plates are nearly always silicified, and this circumstance makes it so extremely difficult to obtain tolerably well preserved specimens. The specimens are always exposed on weathered surfaces of huge limestone blocks, and generally there is no means of separating them from the matrix. Thus, though the species is not very rare, only very few specimens have been brought away by Mr. Wynne or by myself. Specimens of spines as well as of interambulacral plates have been found at Katta, at Golawáli, at Chidru and in the Bazárwán.

Remarks.—It must be very much regretted that no better materials are available of this species, as beyond doubt it is one of the most interesting in the Salt-range. The small fragments available point already to very peculiar characters in the species. If we pass in review all the forms of *Eocidaris* described up to the present, we find that there is only one which on the whole rather nearly approaches the present species, and that is *Eocidaris rossica*, Buch. This species also has interambulacral plates, of a very irregular shape, and apparently very loosely joined together. It is true that Trautschold described this species as an *Archæocidaris;* but its characters, as pointed out by Quenstedt, are those of *Eocidaris* and not of *Archæocidaris.* The absence of a crenulation on the collar round the tubercles must be attributed only to the mode of preservation of the specimens, as Mr. Trautschold himself remarks that on the radials at least, the articulating facet when perfectly well preserved bears such a crenulation that can hardly be absent on the tubercles under like conditions. From our *Eocidaris forbesiana* the Russian species can very easily be distinguished by the much smaller size of the interambulacral plates and their very different outline; also, the radials are much less massive.

Of other forms, chiefly *Lepidocidaris* must be compared. The general characters of the interambulacral plates are very similar in both fossils, but in *Lepidocidaris* the plates are on an average smaller, the tubercles almost minute and devoid of a crenulated collar, and the spines are entirely different.

All the species of true *Archæocidaris* can be easily distinguished from the form here under consideration, by different sculpturing of the interambulacral plates, characteristic of the genus.

Class: CRINOIDEA.

Order: EUCRINOIDEA.

Sub-order: TESSELATA.

Family: *CYATHOCRINIDÆ.*

Genus: CYATHOCRINUS, Mill.

The distinction of this genus from *Poteriocrinus* is very difficult if one has to deal with specimens in which the upper vaulted covering of the body and the arms are not preserved, and the determination of such specimens must always remain somewhat arbitrary.

In general, at least as regards carboniferous and permian forms, one is wont to consider as belonging to the genus *Cyathocrinus* those forms only in which one nearly symmetrical *interradiale anale* is inserted in the cycle of the first radials, so that, though the body is in fact not symmetrical, yet a certain symmetry is attained. On the contrary, the forms generally placed in the genus *Poteriocrinus*, are those in which there occur two or three anal interradials, of which the first is inserted obliquely between one of the parabasalia and one of the radialia, while only the second is distinctly a member of the cycle of the radials.

Both these genera are richly represented in the carboniferous formation of Europe, and extend with a few species up into permian beds. The first of them contains the wide-spread permian species *Cyathocrinus ramosus*, Schloth., while the second has up to the present furnished a representative, *Poteriocrinus quenstedti*, Golovk. only in the Russian permian formation.

In the Salt-range several species occur; they all however seem to correspond more closely with *Cyathocrinus* than with *Poteriocrinus*, though no sufficiently well preserved specimens have been found to allow of a perfectly safe determination.

Two groups of forms can be distinguished among the Salt-range specimens; one group with a small body and a very small lancet-shaped anal interradial piece, and another group with a large body and a squarish anal interradial piece. For both these groups representatives can be found among the species already described from other countries.

The first group has its representative in the well-known *Cyathocrinus ramosus*, Schloth., of the permian formation of Europe, though the specimens from the Salt-range are at least twice as large as those from Europe. The second group is typified by the gigantic species *Cyathocrinus konincki* from upper-carboniferous beds of Australia. Each of these groups is represented in the Salt-range by two species, all of which occur in the middle division of the Productus-limestone.

We have thus within the genus *Cyathocrinus* to distinguish in the Salt-range the following species:—

I.—Group of Cyathocrinus koníncki, Clarke.
  1.—*Cyathocrinus goliathus*, Waagen, n. sp.
  2.— „ *virgalensis*, Waagen, n. sp.
II.—Group of Cyathocrinus ramosus, Schloth.
  3.—*Cyathocrinus indicus*, Waagen, n. sp.
  4.— „ *kattaensis*, Waagen, n. sp.

As will be seen from the names here introduced, none of these four species can be identified with any hitherto described form.

I.—Group of *CYATHOCRINUS KONINCKI*, Clarke.

1. Cyathocrinus goliathus, Waagen, n. sp., Pl. XCVI, figs. 6—12.

The body of this very large species is known to me only from isolated plates, but as nearly every one of the cycles composing the body is represented, the species can be fairly reconstructed.

The body seems to have been somewhat inflated, cup- or balloon-shaped, and was composed of three cycles of plates, *viz.*, the *infrabasalia*, the *parabasalia*, and the *radialia*. Of the *interradialia analia* only one is known to me.

Of the *infrabasalia* none is preserved in the Salt-range collection, but from the impressions left on the *parabasalia*, it appears that this first cycle was composed of five plates, the upper margins of which formed a pentagon with nearly straight sides; but already in this first cycle the *interradius analis* seems to have been marked by a certain irregularity in the plates, as the lower margin of the lateral *parabasalia* is developed unsymmetrically. The *parabasalia* are of a more or less regularly pentagonal outline, the height being equal to the breadth, while the *parabasale* which was in contact with the *interradiale anale*, was probably hexagonal, but no specimen of this plate is preserved in the Salt-range collection. The *parabasalia* are all well vaulted, but otherwise they are smooth, without any sculpturing. Of the *radialia*, probably only three were of a quite regular shape, while the two adjoining the *interradiale anale* were probably more or less irregular. As it is, only a few radial pieces of a quite regular shape have been found. They are depressed, pentagonal, much broader than high, the entire upper breadth being occupied by a large articulating facet. At its upper extremity the plate extends internally in a somewhat swallow-tailed process. The outer surface of these radial pieces is strongly vaulted and smooth. The greatest breadth of these *radialia* is at their lower extremity, so that the whole body must have been contracted at its upper margin, as we see to be the case in *Cyathocr. konincki*.

On Plate XCVI, fig. 9, I have figured a plate which I take to be an *interradiale anale*. The piece is irregularly four-sided and of an unequal thickness, being thicker to the right than to the left—a condition which might however have been produced by abrasion before the piece had been imbedded, and the strata in which these crinoids are found do show signs of strong wave-action at the time of their deposition.

The piece is vaulted outside and smooth. The irregularity of the general outline of this piece suggests the probable existence of some other *interradiale anale.*

The stems with much probability belonging to this species are thick, round, composed of numerous low entrochi (joints), four to five times as broad as they are high. They are often thickly and irregularly set with cirrhi, but they just as often quite smooth. The articulating facets of the joints show a large round median canal, surrounded by a narrow belt of fine granulation, after which a rather broad smooth zone follows, while along the margin a rather coarse radial notching occurs.

It is not possible to give any measurements, as only fragments of the species are known, and the dimensions of these may best be seen from the drawings. On the whole, it is very probable that the form of the body was to a certain extent balloon-shaped, as is the case in *Cyathocr. konincki,* the greatest breadth not being situated at the upper margin, but about in the middle height of the body.

Locality and geological position.—This is one of the commonest species of the Salt-range, as fragments of it fill all the beds of crinoidal limestone in the middle division of the Productus-limestone, which attain locally a thickness of more than a hundred feet. But though the fragments are thus heaped together by millions, yet I never found a complete body. Mostly the fragments are strongly rolled and broken, indicating a strong wave-action during the formation of these crinoid-limestones; only very rarely are well preserved single plates of the body found, when the limestones become more marly in certain beds. Such is the case at Virgal, where marly beds of a red colour are intercalated between the compact limestones, and in these marls some better specimens can be obtained. Other such localities were west of Khura, at the base of the upper Productus-limestone, and at the village of Khura itself, in the top beds of the middle division, also in the Chittawán and at Bilot.

Remarks.—The species which seems to be most nearly related to the one under description is *Cyathocrinus konincki,* Clarke, which has been described by Mons. de Koninck from carboniferous beds of Osterley on the Hunters River of Australia. The diagram given of this species by Mons. de Koninck is however not in accordance with the other figures, as in this diagram the *infrabasalia* are triangular in shape, and correspond by one of their sides with the basal side of the *parabasalia,* while in the other figures the *infrabasalia* are quadrangular and alternate with the *parabasalia.* I think the diagram must be erroneous, and the other figures correct. If we now take these representations for comparison with the Indian specimens, we find that there exists a strong typical resemblance between the two, and it appears highly probable that the body of *Cyath. goliathus,* W., had the same general globular shape as *Cyathocr. konincki.* But other well-marked differences exist. The Indian species is much smaller, and its parabasalia are without radiating ridges. Thus it is evident that they form two distinct species, but it is interesting to observe here a form so nearly related to an Australian species, as such an occurrence is rare in the Salt-range fossils.

Of other species none is known to me which could be more particularly compared to *Cyathocr. goliathus,* W.

2. Cyathocrinus virgalensis, Waagen, n. sp., Pl. XCVI, figs. 13-15.

Another but a much smaller form seems to be indicated by some *parabasalia* and several fragments of stems collected by me at Virgal, but the materials are very scanty.

The *parabasalia* are irregularly five-sided, or somewhat six-sided, as the basal faces of the plates are made up of two rather indistinct facets. They are flatly vaulted in every direction and quite smooth. Their chief character however consists in the circumstance that they are somewhat broader than high.

Of the remaining plates of the body, nothing is known to me.

To the same species belong with great probability some fragments of stems that are not very thick and decidedly beaded, each joint being somewhat swollen in the middle. The joints are irregular in thickness, but generally they are comparatively higher (thicker) than in *Cyathocr. goliathus*. The articulating facet is pierced in the middle by a large canal and bears a rather coarse notching along its circumference.

Locality and geological position.—The species seems on the whole not rare, though it is certainly rarer than the preceding one. It has however no doubt furnished a large contingent of the fragments with which the crinoid beds of the middle Productus-limestone are filled. The parabasal plates, described above, were found by myself in the same red marl-beds at Virgal which furnished the pieces of *Cyathocr. goliathus*. Fragments of stems probably belonging to the species were collected by me at Virgal in the Coral and Crinoid-beds, and in the Chittawán (middle Productus-limestone).

Remarks.—It might appear somewhat doubtful whether the present species should be separated under a distinct name from the preceding one, as in general appearance the *parabasalia*, the only parts that are known to me, very much resemble the same parts of *Cyathocr. goliathus*, and are chiefly distinct only by their smaller size, so that it appears very possible that they only represent the young state of the larger species. I held this opinion myself for some time, but after careful consideration I came to distinguish the forms, as very probably indicating the existence of two different species. The smaller plates presented a very constant size, and always deviated from the larger ones by the circumstance that the transverse diameter was greater than the height, while in the larger plates both dimensions are always exactly identical, also the shape of the smaller specimens was always more strongly unsymmetrical than was observed in the majority of specimens of *Cyathocrinus goliathus*.

Thus it appeared to me highly probable that the smaller plates belonged to a species different from *Cyathocr. goliathus*, and accordingly I introduced a new name for this species.

From *Cyathocr. konincki*, Clarke, the present species is easily distinguishable by its much smaller size, and by the smooth parabasal plates. It is however probable that also *Cyathocr. virgalensis* bore a certain affinity to that Australian species.

II.—Group of *CYATHOCRINUS RAMOSUS*, Schloth.

3. Cyathocrinus indicus, Waagen, n. sp., Pl. XCVI, fig. 1.

The materials of this species, though not very complete, are yet sufficient to give a tolerably full description of it, the complete body, without the arms, and the stem being known to me.

The species is of rather small dimensions, although nearly twice as large as the true *Cyathocrinus ramosus.*

The body is of an elevated conical outline with entirely straight or but very little vaulted sides. It is composed of three cycles of plates, *viz.*, the ***infrabasalia***, the ***parabasalia*** and the ***radialia***. The ***infrabasalia*** are five in number, and of an approximately quadrangular outline. In general configuration however they appear geniculated, the truly basal part being turned inside and forming a little triangle, all five triangles together composing a round, articulating, facet for the insertion of the stem. That part however which belongs to the outer wall of the body is turned up, and shows on the whole a pentagonal outline. It is somewhat vaulted transversely, according to the curvature of the outline of the articulating facet below. This pentagonal upright part of the infrabasal plates is about as high as it is broad. The angle by which it is marked off from the basal part is obtuse and rather sharply marked.

The ***parabasalia*** are also five in number, alternating with the ***infrabasalia***. They are much larger than the latter and a little vaulted in every direction. Four of them are pentagonal, the lower side often forming a broken line; the pentagons are somewhat higher than broad. In the fifth plate the upper corner of the pentagon is cut off, and thus this plate becomes hexagonal, though the sixth side is very short. To this short sixth side the very small ***interradiale anale*** is joined.

The five ***radialia*** alternate again with the ***parabasalia***. They are all of an about equal shape, short and broad, and on the whole smaller, but more massive than the latter. Their general outline is short, reversed, pentagonal, the longest side being above and nearly for its entire length occupied by an articulating facet. The surface of the ***radialia*** is vaulted longitudinally as well as transversely. Two of the ***radialia*** are very slightly irregular in their outline, being a little shortened on one side, to give room for the very small ***interradiale anale*** which is inserted between them.

The single ***interradiale anale*** in hand is very narrow, lancet-shaped, and of a somewhat hexagonal outline. It projects rather far above the ***radialia*** by which it is hemmed in on both sides. Its outer surface however is sunk in between the radialia, and marks a rather deep impression on the body. On its lower side it is joined to that one of the ***parabasalia*** which is hexagonal by its upper corner being cut off in a straight line.

The stem of this species is very distinctly beaded. Each joint is inflated in the middle and bears on its upper and lower sides somewhat raised articulating facets. As these facets have a smaller diameter than the body of the joints, it comes that each joint bears at its lower and upper end a smooth ring, caused by the raised position of the articulating facets. The beads of the stem, which are made up of the swollen bodies of the joints are thus separated from each other, by smooth deepened spaces. The articulating facets themselves bear a ring of short notches all round the periphery. The median part is smooth and pierced in the middle by a not very large round nutrition-canal.

The dimensions of the body are as follows :—

Entire height of the body	11·5	mm.
Greatest diameter at the upper end	14	„
Diameter of the articulating facet at the lower extremity	5	„
Greatest height of the *infrabasalia*	3	„
„ breadth „ „	3·5	„
„ height „ *parabasalia*	7	„
„ breadth „ „	6	„
„ height „ *radialia*	4·5	„
„ breadth „ „	9	„
Height of the *interradiale anale*	4	„
Breadth „ „ „	1·5	„
Angle formed by the lateral walls of the body	60°	

Locality and geological position.—Up to the present there has been found only one entire body of this species. This was collected by myself at Nursingpohár in the black sandy-limestones, forming there the base of the middle division of the Productus-limestone. Fragments of the stem were found in the immediate vicinity of the body, so that it appears highly probable that both belonged to one and the same species. Very similar stem fragments, which with great probability can be assigned to this species, were collected by me also at Amb in the lower division of the Productus-limestone, in the very lowest fossiliferous beds above the lavender-clays.

Remarks.—The present species seems to be very nearly related to *Cyathocrinus ramosus*, Schloth, the widely spread permian species of Europe. It is very much to be regretted that the body of *Cyathocrinus ramosus* is so very rare that up to the present the exact characters of the species have remained somewhat doubtful. The specimen described by King was damaged at its base, and thus the shape of the *infrabasalia* could not be made out; the *parabasalia* and *radialia* were well preserved and it could be stated, that in the anal interradius three *interradialia analia* were present; the general shape of this specimen is flatly conical. On the specimen described by Geinitz in his memoir on the Nebrasca fossils, the *infrabasalia* are on the contrary well preserved but small. Of *interradialia analia* there is only one present, and the whole shape of the body is more elevated conical. From this it becomes highly probable, that in the European permian beds two different species of *Cyathocrinus* exist, of which the German specimen would represent the true *Cyathocrinus ramosus*, Schloth, while the English specimen would probably have to receive a new name. As it is, the Indian specimens show a more close affinity to the typical German form than to the English one.

They are nevertheless easily distinguishable from the German typical *Cyathocrinus ramosus*. Already the much larger size of the Indian species is an acceptable distinguishing character. To this can be added the different shape of the *interradiale anale*, which is much broader and shorter in *Cyathocr. ramosus* than in the Indian species. Otherwise the two forms are very similar and can perhaps be considered as vicarious species of an approximately equal geological age.

4. CYATHOCRINUS KATTAENSIS, Waagen, n. sp., Pl. XCVI, fig. 2.

Also of this species there exists only a single body, which was collected by myself. But though the material thus seems to be rather scanty, yet this body deviates so considerably from the one described before that I cannot unite both under one name, but have to consider the present one as belonging to a different species.

The body is small and flatly conical or cup-shaped. The sides are tolerably flat, the single plates however being somewhat vaulted. The whole body is composed of three cycles of plates, the *infrabasalia*, the *parabasalia* and the *radialia*. Of each of them five are present.

The *infrabasalia* have on the whole a geniculated shape, as one part of them is bent inside to form the articulating facet, at the insertion of the stem, while the remaining part is bent up and forms part of the lateral walls of the body. This bent-up part, which alone is visible in a lateral view of the body, is very narrow and of an approximately quadrangular outline. It is flat, not inflated, and is bent only in the general curve of the body. The upper margins of two adjacent infrabasal plates fall into one line, the five plates thus forming together a regular pentagon.

The *parabasalia* are all regularly pentagonal, with the exception of one. In each single plate the basal side is longest, and the two lateral sides shortest. It thus happens that the pentagons become considerably broader than long. While this is the shape of four of the parabasalia, the fifth is hexagonal, with its upper corner cut off and replaced by a short sixth-side, for the reception of the base of the very small *interradiale anale*. All the *parabasalia* are slightly inflated and present a surface vaulted in every direction.

The *radialia* are all tolerably equal in size and shape, only two of them are slightly shortened laterally to make room for the small *interradiale anale* mentioned above. Their shape is very strongly pentagonal transversely, the longest side being above, bearing an articulating facet nearly as long as the whole plate. The shortest sides of the pentagon are the two lateral ones, while the two remaining are of a medium size. These radial pieces are rather thickly swollen in the middle of the upper margin while they are somewhat attenuated towards the lateral extremities, whereby little grooves are formed where two of the radialia meet.

The single *interradiale anale* has been lost in the specimen that serves for description. From the place it once occupied, it can however be judged that it was very small and narrow, probably in shape similar to that of the preceding species.

The stem of this species is well known, and there can be no mistake about it, as portions of it were found by me in connection with the body, though in detaching the specimen the stem was broken to pieces. The stem is remarkably thin, and composed of rather high smooth cylindrical joints, which are as high as they are broad. The articulating facets are smooth in the middle, with a row of small notches all round, and pierced in the centre by a very small canal. On the whole the stem is very similar to that of *Encrinus*.

The measurements of the body here described are as follow :—

Entire height of the body	10	mm.
Greatest diameter at the upper end	18	„
Diameter of the articulating facet at the lower extremity	4	„
Greatest height of the *infrabasalia*	2	„
„ breadth „ „	4·5	„
„ height of the *parabasalia*	6	„
„ breadth „ „	7·5	„
„ height of the *radialia*	5	„
„ breadth	11·5	„
Breadth of the *interradiale anale*	1	„
Angle made by the lateral walls of the body	82°	

Locality and geological position.—The only specimen of this species known to me was collected by myself at Katta in yellow limestones forming the base of the middle division of the Productus-limestone (bed No. 12 of my note book). The stem was still attached to the body, but the arms were wanting.

Remarks.—The species here under consideration is very nearly related to the preceding one, but is easily distinguishable by the different shape exhibited by the whole body, and the different development of each of the three cycles of plates composing the body. It needs only a comparison of the measurements given of the two species to become aware of these differences. The exceptional thinness of the stem is also a character worthy of notice. All these differences are not very much it is true, but they seemed to me quite too considerable to admit of uniting under one specific name the two forms here described.

To the true *Cyathocr. ramosus*, Schloth, the present species is perhaps still more nearly related than the preceding one, but also in this case the size of the Indian species is about twice that of the European permian form, and also the shape of the single plates is somewhat different. The genus *Phialocrinus* of Trautschold might also be compared.

Family :—*POTERIOCRINIDÆ.*

Genus ? HYDRIOCRINUS, Trautschold.

It is in an absolutely provisional way that I quote here this genus of Trautschold's. There is nothing from which I could with any certainty deduce the presence of the genus in the Salt-range. The sole reason which induces me to allude to it is the occurrence in the Salt-range of five-sided stem fragments which might possibly, as *Hydriocrinus* is said to have a pentagonal stem, have pertained to an animal belonging to the genus. It is quite true that *Hydriocrinus* is not the only genus in which a pentagonal stem occurs, but it is a genus of the upper carboniferous limestone of Russia, and the same genus might perhaps also have extended into the Productus-limestone, as the latter is not so very far different in age from the former.

Phialocrinus also, a genus which occurs together with *Hydriocrinus*, is said to have a pentagonal stem; but as no figure of the stem has been given by Trautschold, a comparison is impossible.

1. ? Hydriocrinus, sp. indet; Pl. XCVI, figs. 3, 4, 5.

All that has been found of this species up to the present in the Salt-range are some joints of the stem, which show a decidedly pentagonal outline.

These joints are generally very flat, their height being not more than one-fourth of the diameter. The sides of the pentagon are mostly impressed, so that the corners project considerably; sometimes however the sides are straight. Vertically the sides of the joints are always rounded, so that the stems must have shown a transversely ridged appearance, as in *Pentacrinus cingulatus*. Some of the joints bear articulating facets on every one of the five sides, for the reception of lateral cirrhi. The articulating facets, by which each joint is terminated above and below, are hollowed out, and bear in the middle a smooth pentagonal face which is again pierced in its centre by a rather large round canal. Along the margins of the facets rows of notches of unequal size are observable, the longest being in the middle, while towards the corners they become very small.

It seems unnecessary to give any measurements of these small objects, as their dimensions can be sufficiently seen from the figures given on Plate XCVI.

Locality and geological position.—Fragments of stems of pentagonal outline are rather rare in the Salt-range, and are restricted apparently to the upper division of the Productus-limestone. Some specimens were found by myself in the hills east of Katwáhi in the lower beds of the upper division, and another specimen I detected in the light-coloured sandstones forming the topmost beds of the same division at Virgal.

Remarks.—Though these pentagonal joints of crinoid stems seem to be very insignificant, yet it is remarkable that very similar things have also been found elsewhere in beds of a similar geological horizon. There has been described by Golovkinsky something very similar from permian beds of the Kama-Wolgaie basin of Russia under the name of *Pentacrinus*, sp. Now it seems to me that neither the permian specimen nor the specimens from the Salt-range can rightly be placed in the genus *Pentacrinus*, as none of them has the characteristic leaflets of notches with which the articulating facets of *Pentacrinus* are provided, the notches form simple rows along the margins of the pentagonal articulating facets. From this it appears that these fossils can with some probability be placed in some palæozoic genus of crinoids but not in *Pentacrinus*.

Genus: POTERIOCRINUS, Mill.

The indication of the existence of this genus cannot be founded on any firmer ground than has been offered for the preceding genus. There are merely some fragments of stems in the collection that I attribute in a somewhat arbitrary manner to the genus *Poteriocrinus*. As due excuse for this proceeding it might perhaps suffice that I consider the beds in which these fossils occur as of probably permian age, and that in the permian formation besides the genus *Cyathocrinus* only the genus *Poteriocrinus* has been found up to the present. The stems now under consideration belong to none of the species of *Cyathocrinus* described above, and there may perhaps be indicated by them the existence of species of *Poteriocrinus*. This is all I can say in favour of my determination.

There are two different shapes of stems, which might perhaps belong to the present genus, but none of which can receive a specific designation. By figuring and describing them I may perhaps draw to this point the attention of some later visitor to the Salt-range, to search for the bodies of these forms.

1. ? POTERIOCRINUS sp., ind., Pl. XCVI, figs. 16, 17, 18.

The stem-fragments here under consideration are rather thick, and belong to a large species. They are composed of low joints which are either all of an equal thickness or alternately thicker and thinner. Their height is very often not more than a tenth of their diameter, while in other specimens it increases to a sixth of the same. These thicker joints mostly bear laterally small articulating facets for the insertion of cirrhi. The lateral walls of the joints are always quite smooth, never swollen or vaulted. The articulating facets, limiting the joints above and below, are pierced in the middle by a not very large round canal, and their whole surface is provided with a fine radial striation, which begins at the centre and extends to the margin. It is composed of fine elevated ridges, which augment towards the margin either by being dichotomous or by the insertion of new ridges between the old ones.

A piece of the root figured in Plate XCVI, figure 18, shows very irregular joints.

Locality and geological position.—Fragments of stems of this description are not very numerous in the Salt-range, but occur off and on in the middle as well as in the upper division of Productus-limestone. The species has been found somewhat more numerously by Mr. Wynne at Morab in the middle division, and by myself in the *Cephalopoda*-bed of the upper division at Jabi.

Remarks.—Stem-fragments of a similar description to those described here are found throughout the palæozoic formations, and there would be no apparent use in entering here upon comparisons. All that is needed is to register the occurrence of such stems in the Salt-range.

2. ? POTERIOCRINUS, sp. ind., Pl. XCVI, figs. 19, 20.

The fragments of stems that I consider as having belonged to a species different from the preceding are much less considerable in thickness, and indicate an altogether smaller species.

The stems are of a moderate thickness, with rather high joints, and perfectly smooth and cylindrical, apparently without lateral cirrhi. The height of the joints is about one-third to one-half of their diameter, and in this respect and in their smooth surface they resemble exceedingly the entrochi of *Encrinus liliformis.* They differ however considerably from that species by the characters of the articulating facets. These are smooth for the greater extent, and pierced in the middle by a large pentagonal canal. Round the margin there are short coarse notches as in *Encrinus.*

Locality and geological position.—Of all the crinoid stems occurring in the Salt-range, the ones here under consideration are the rarest. They are restricted to the middle Productus-limestone, and have been found in single fragments by myself and Mr. Wynne at Katta, at Khura and at Bilot.

Remarks.—The stem-fragments here under consideration are distinct from all the others, occurring in the Salt-range by their pentagonal canal. Joints of a similar description occur however in several palæozoic formations and their occurrence in the Salt-range is of no geological value.

Family: *HETEROCRINIDÆ.*

Genus: PHILOCRINUS, Koninck.

This genus was created by Mons. de Koninck for a fossil coming from the Salt-range; but though this is the case I can give but little new information on it, as tolerably well preserved specimens are very rare, and there is none in the collection to show all the characters necessary for the proper definition of the genus.

The genus was originally characterised by Koninck in the following manner:—" The characters consist chiefly in the existence of five basal-plates of a quadrangular form, alternating with five rows of radial plates, to the number of two for each ray. The second plate is cuneate, and supports two series of brachial plates, also two in number; each of these, finally, giving support to two series composed of a great number of brachial plates, thus producing about twenty free arms. All the other plates are soldered one to the other, and form the calyx." The genus is then compared to *Encrinus* and *Millericrinus*, and is said to differ from them in having only two radial pieces whereas they have three.

This description was drawn up from a specimen that is now lost, and in the Salt-range collection there is not one so complete. Nevertheless on one of the specimens at my disposal something can be observed that was not visible on Mons. de Koninck's specimen, and this is a small *interradiale anale.* Thus the diagnosis of the genus can now be drawn up somewhat more completely than heretofore.

The diagnosis may be framed in the following manner, according to the nomenclature introduced in Zittel's Hand-book. It remains doubtful whether there were *infrabasalia* or not; on the whole however it seems rather probable that small infrabasalia were present. The *parabasalia* are comparatively large, much higher than broad, of an elongated pentagonal shape. They are all five absolutely identical in outline, and the anal interradius cannot be distinguished in this cycle by any deviating shape of one of the plates. The *radialia* alternate with the *parabasalia*, and three of them are of a broadly pentagonal outline. The remaining two are hexagonal, as a small *interradiale anale* is partly sunk in between them. The upper margin of the *radialia* is entirely taken up by a large articulating facet to which the first *brachiale* is joined. The small *interradiale anale* is of an irregular pentagonal shape. It is only partly inserted between two of the *radialia*, not reaching down to one of the *parabasalia* but stopping half-way. One of the sides is joined laterally to one of the *brachialia*, whilst the last remaining side seems to have been in connection with a second *interradiale anale*, which was inserted between the *brachiale* on the other side and the first *interradiale*.

The first *brachialia* are axillary, and in shape similar to the *radialia*, only reversed, the longest side being below, articulating with the upper facet of the radialia. All five have about the same shape, only the two adjoining the *interradialia analia* are somewhat narrower.

After the first brachialia follow two more, of which the second is again axillary, so that altogether twenty arms are formed.

The arms do not divide again. They are made up of alternating pieces.

These are the characters of the genus. It has till now been supposed that the genus had no *interradiale anale;* but a specimen from Bilot shows most clearly the existence of such.

The genus was for a time considered to be identical with *Erisocrinus*, Meek and Worthen, but this opinion was soon given up again by this author himself. Now, after the existence of an *interradiale anale* has been demonstrated in *Philocrinus* the affinity is still far more remote. The systematic position of the genus *Philocrinus* cannot however be altered by this discovery. The *interradiale anale* is not in connection with one of the *basalia*, but is in its position very similar to the small *interradiale anale* of *Graphiocrinus*, Kon., and this position, I think, is essential for the retention of the genus in the *Heterocrinidæ* of Zittel. From *Graphiocrinus* the genus is easily distinguishable by an entirely different shape of the body and the existence of twenty instead of ten arms.

There exists only one species of the genus in the Salt-range.

1. PHILOCRINUS COMETA, Koninck., Pl. XCV, figs. 17—20.

1863. *Philocrinus cometa*, De Koninck: Quart. Journ. Geol Soc. Lond., Vol. XIX, p. 4, Pl. II, fig. 5.
1863. *Philocrinus cometa*, De Koninck: Fossiles paléozoiques de l'Inde, p. 21, Pl. II, fig. 5.

The body is of moderate size and of a thick obtusely conical outline. There has no specimen been found up to the present with the base of the body perfectly preserved, and therefore it is not known whether there existed infrabasal plates or not. The *parabasalia*, the *radialia*, and the different brachial plates are of the description indicated in the characteristic of the genus. All these plates are perfectly smooth and not vaulted, except according to the general curvature of the surface of the body. The arms are long, simple, and for their whole extent of about equal thickness. They are made up of rather thick alternating joints, and there have not been observed up to the present any traces of pinnulæ. The arms adjoining the anal interradius seem not to differ from the remainder.

The stem of the species is not known with certainty, but very probably the fragments figured by me, Pl. XCV, fig. 20 belong to it. They are made up of rather thin joints in which the height is about one-third of the diameter. Their general form is round with slightly vaulted sides, so that the whole stem appears very slightly beaded. Cirrhi have not been observed by me. The articulating facets are smooth for the greater extent, and are pierced in the middle by a rather large canal. All round the periphery the facet bears a tolerably fine notching.

The measurements are approximately the following:—

Entire height of the body, up to the last splitting of the arms	28	mm.
Height of the body up to the first brachiale	16	„
Greatest transverse diameter of the body	25	„
„ height of the *parabasalia*?	9	„
„ breadth of the „	8	„
„ height of the *radialia*	5	„
„ breadth of the „	9	„
„ height of the first *brachiale*	6	„
„ breadth „ „ „	11	„
Height of the *interradiale anale*	4	„
Breadth of the „ „	5	„
Angle made by the lateral walls of the body	35° to 55°	
Length of the arms, about	60	„

Locality and geological position.—Well determinable bodies of this species are very rare. One was collected by Mr. Wynne at Bilot. Where the specimen described by Mons. de Koninck came from is not known. As far as my experience goes, the species is restricted to the compact limestones of the middle Productus-limestone, in which beds Mr. Wynne's specimen also was collected. The fragments of stems which I assign to this species are much more common. I collected such specimens at Katta in the compact limestones, in the hills east of Katwáhi and in the Bazáwán.

Remarks.—The genus *Philocrinus* has for a time been identified by Meek with *Erisocrinus*, and thus it might be useful to compare the species of that genus with *Philocrinus cometa*. It has already been shown in the description of the genus that this identification of the two genera was erroneous, and that in fact they deviate widely from each other; as of course do also the species. The same is the case with the genus *Graphiocrinus*, Kon. and also in this case a close comparison of the species is out of the question. It thus appears, that *Philocrinus cometa* is a strongly isolated form in the generic as well as in the specific characters.

As far as is now known, the genus as well as the species seems to be restricted to the Salt-range and has been found nowhere else.

PLATE LXXXVII.

PRODUCTUS-LIMESTONE.

Figure 1, 2, 3. **Fenestella perelegans**, Meek, p. 777. 1, a small fragment of the colony, showing the poriferous side, from the upper region of the middle Productus-limestone of Musakheyl; 1*a*, natural size; 1*b*, strongly enlarged (somewhat too schematical). 2, fragment of a colony, showing the non-poriferous side, from the uppermost beds of the middle Productus-limestone of Khura; 2*a*, natural size; 2*b*, part of the same strongly enlarged. 3, a nearly entire colony, exposed from the non-poriferous side, from the middle Productus-limestone of Gulámi (Trans-Indus); 3*a*, natural size; 3*b* &c., preparations of the poriferous side, enlarged.

4. **Fenestella jabiensis**, Waagen & Pichl, n. sp., p. 778. Fragment of the colony, showing the non-poriferous side, from the uppermost beds of the middle Productus-limestone of Khura; 4*a*, natural size; 4*b*, part of the same enlarged. (See also Pl. LXXXVIII, fig. 1, 2.)

5. **Polypora koninckiana**, Waagen & Pichl, n. sp., p. 783. Fragment of a colony, showing the poriferous side, from the upper region of the middle Productus-limestone of Musakheyl: 5*a*, natural size; 5*b*, the entire fragment enlarged; 5*c*, two branches, with well-preserved surface, still more strongly enlarged; 5*d*, two other branches, the surface, worn by weathering, also very strongly enlarged. (See also Pl. LXXXVIII, fig. 4, and Pl. XC. fig. 1.)

SALT-RANGE FOSSILS.

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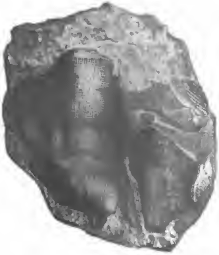

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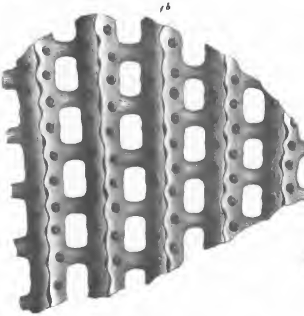

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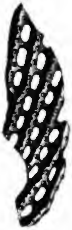

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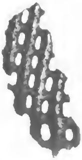

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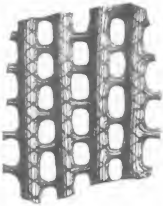

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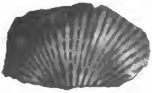

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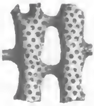

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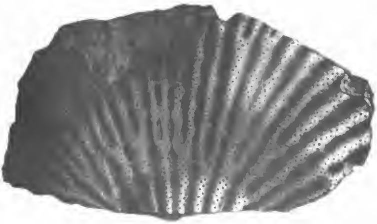

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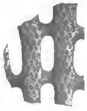

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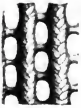

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A. Swoboda del. et lith.

Th. Bannwarth pinx.

PLATE LXXXVIII.

PRODUCTUS-LIMESTONE.

Figure 1, 2. Fenestella jabiensis, Waagen & Pichl, n. sp., p. 778. Fragment of the colony from the *Cephalopoda*-bed of the upper Productus-linestone of Jabi: 1, a portion detached and prepared to show both sides; 1*a*, the poriferous side, natural size; 1*b*, the same enlarged; 1*c*, the non-poriferous side, natural size; 1*d*, the same enlarged (of these figures 1*b* is not quite correct; for particulars see the text). 2, the remainder of the specimen, showing the non-poriferous side, natural size. (See also Pl. LXXXVII. fig. 4.)

3 (*cf.* 5—7). Polypora megastoma, Koninck, p. 785. A fragment of the upper part of the colony showing the non-poriferous side; from the middle region of the middle Productus-limestone of Morah: 3*a*, natural size, to the right the branches are ground down to expose the cells; 3*b*, part of the abraded surface strongly enlarged. (See also Pl. LXXXIX. fig. 3.)

4. Polypora koninckiana, Waagen & Pichl, n. sp., p. 783. Fragment of the colony showing the non-poriferous side, from the upper Productus-limestone of Chidru; 4*a*, natural size; 4*b*, part of the same strongly enlarged. (See also Pl. LXXXVII. fig. 5, and Pl. XC. fig. 1.)

5, 6, 7 (*cf.* 3). Polypora megastoma, Koninck, p. 785. 5, a fragment adjacent to the root, showing the poriferous side, from the middle Productus-limestone of Káfirkót; 5*a*, natural size; 5*b*, enlarged. 6, fragment from the peripheral parts of the colony showing the non-poriferous side, from the middle Productus-limestone of Morah. 7, fragment adjacent to the root, non-poriferous side, from the same bed and locality as the preceding.

SALT-RANGE FOSSILS.

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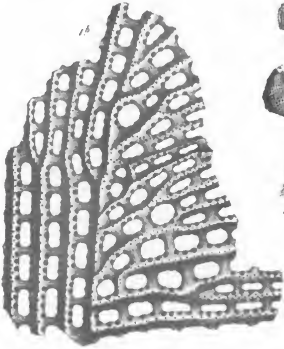

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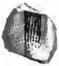
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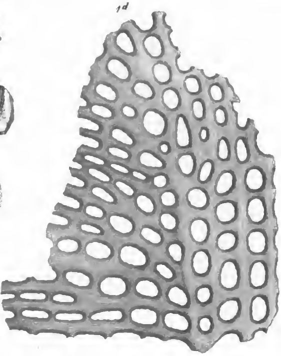

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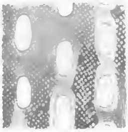

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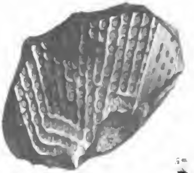

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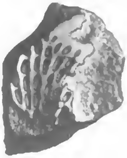

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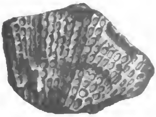

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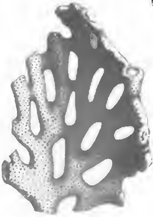

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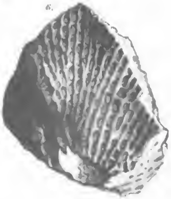

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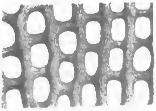


A Swoboda del et lith.

Th Bannwarth pinx

PLATE LXXXIX.

PRODUCTUS-LIMESTONE.

Figure 1, 2. **Polypora gigantea**, Waagen & Pichl, n. sp., p. 786. 1, a large fragment of a colony, silicified and much weathered, exposed from the non-poriferous side, from the middle Productus-limestone of Ramkhund, Trans-Indus, natural size. 2*a*, fragment of a colony not silicified and on the whole well preserved, showing the non-poriferous side, from the middle Productus-limestone of Morah, natural size; 2*b*, fragments of the same specimen prepared to show the poriferous side; 2*c*, the same strongly enlarged.

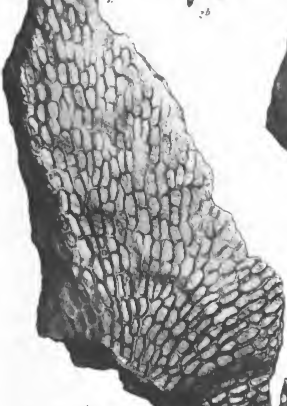
3. **Polypora megastoma**, Koninck, p. 785. Fragment of the peripheral part of a colony showing the proriferous side, somewhat strongly weathered, from the middle Productus-limestone of Ramkhund, Trans-Indus: 3*a*, natural size; 3*b*, part of it strongly enlarged. (See also Pl. LXXXVIII. fig. 3, 5—7.)

4, 5, 6. **Polypora ornata**, Waagen & Pichl, n. sp., p. 788. 4, a small fragment of the colony, showing the non-poriferous side, from the middle beds of the middle Productus-limestone of Khura: 4*a*, natural size; 4*b*, the same enlarged. 5, a somewhat larger fragment of a colony, showing the non-poriferous side, from the top-beds of the middle Productus-limestone of Khura: 5*a*, natural size; 5*b*, part of it enlarged, showing the surface exceptionally well preserved. 6, a small fragment of the specimen represented in fig. 5, prepared to show the poriferous side: 6*a*, natural size; 6*b*, strongly enlarged.

Geol. Surv. of India.

SALT-RANGE FOSSILS.

Pl. LXXXIX.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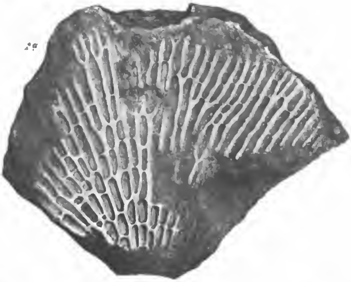
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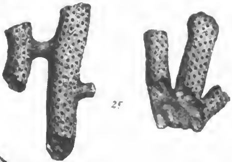
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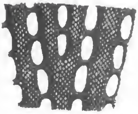
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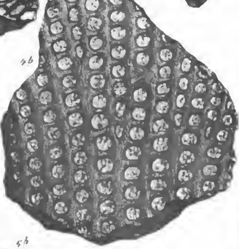
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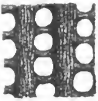
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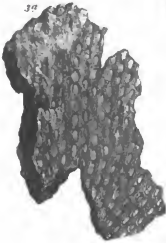
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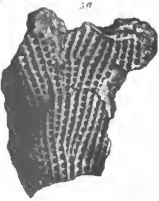
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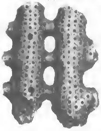
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4a

A Swoboda del et lith

Th Bannwarth print

PLATE XC.

PRODUCTUS-LIMESTONE.

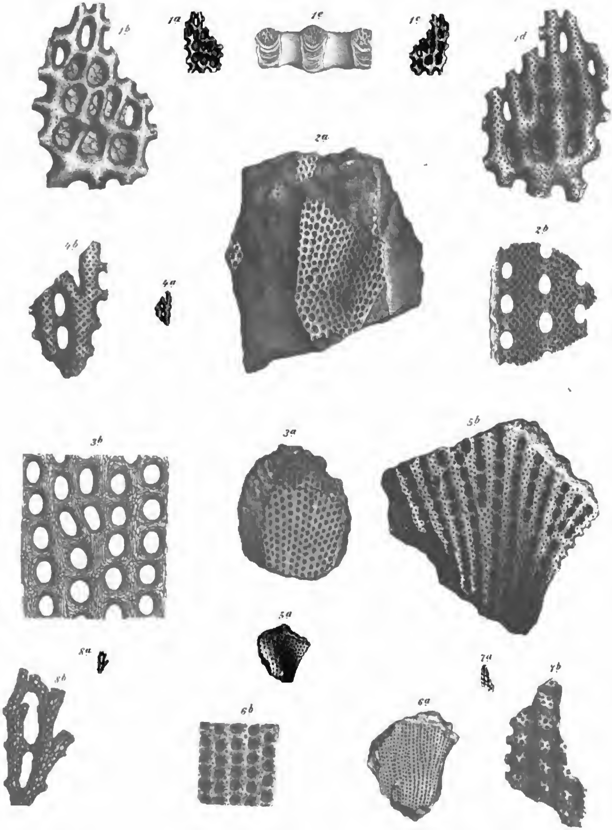
Figure 1. **Polypora koninckiana**, Waagen & Pichl, n. sp., p. 783. Fragment of a very old colony with exceedingly thickened basal-plate, from the *Cephalopoda*-bed of the upper Productus-limestone of Jabi: 1*a*, non-poriferous side, natural size; 1*b*, the same enlarged; 1*c*, poriferous side, natural size; 1*d*, the same enlarged; 1*e*, transverse section to show the enormously thickened basal plate, enlarged. (See also Pl. LXXXVII, fig. 5, and Pl. LXXXVIII, fig. 4.)

2, 3, 4. **Polypora ornata**, Waagen & Pichl, n. sp., p. 788. 2, a fragment of a colony weathered in a singular manner, exposing the fenestrules as funnel-shaped, from the middle Productus-limestone of Omarkheyl; 2*a*, natural size; 2*b*, part of the branches ground down and enlarged, showing the pores. 3, a fragment of a colony weathered down rather evenly, showing the non-poriferous side; from the middle Productus-limestone of Morah; 3*a*, natural size; 3*b*, part of it strongly enlarged. 4, a fragment of the specimen represented in fig. 3, prepared to show the poriferous side; 4*a*, natural size; 4*b*, strongly enlarged. (See also Pl. LXXXIX, fig. 4, 5, 6.)

5, 6, 7. **Polypora biarmica**, Keyserling, p. 791. 5, a fragment of a colony showing the poriferous side, from the *Cephalopoda*-bed of the upper Productus-limestone of Jabi; 5*a*, natural size; 5*b*, the same enlarged. 6, a fragment of a colony showing the non-poriferous side; from the *Cephalopoda*-bed of the upper Productus-limestone of Chidru: 6*a*, natural size; 6*b*, part of the same enlarged. 7, a fragment of the specimen represented in fig. 6, prepared to show the poriferous side; the surface had been much weathered and deteriorated already before the specimen was imbedded; 7*a*, natural size; 7*b*, the same enlarged.

8.? **Synocladia virgulacea**, Phillips, p. 802. Probably a fragment of a very young colony, showing the poriferous side, from the upper beds of the middle Productus-limestone of Musakheyl: 8*a*, natural size; 8*b*, the same enlarged. (See also Pl. XCII, fig. 4 and XCIII, fig. 1, 2.)

SALT-RANGE FOSSILS.



A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE XCI.

PRODUCTUS-LIMESTONE.

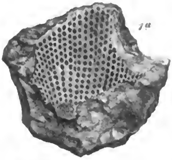
Figure 1—2. **Polypora sykesi**, Koninck, sp., p. 789. 1, a fragment of a colony from the upper beds of the middle Productus-limestone of Musakheyl, showing the non-poriferous side; 1*a*, natural size; 1*b*, portion of the surface enlarged; 1*c*, some branches ground down to show the pores enlarged. 2, a fragment from the middle Productus-limestone of Morah, showing the non-poriferous side, and being weathered in a singular manner, so as to expose the funnel-shaped fenestrules, natural size.

3, 4, 5. **Polypora transiens**, Waagen & Pichl, n. sp., p. 795. Three fragments from the middle Productus-limestone of Morah, showing all three the non-poriferous side. 3, a fragment of the peripheral parts of the colony; 3*a*, natural size; 3*b* and *c*, part of the same specimen prepared as to show the poriferous side; 3*b*, enlarged; 3*c*, natural size. 4, a large fragment of the colony adjacent the root, natural size. 5, a fragment of the peripheral parts of the colony; 5*a*, natural size; 5*b*, a part ground down and enlarged to show the pores, on the dissepiments there is often no space free of pores.

6. ? **Fenestella**, *sp. indet.*, p. 780. A very badly preserved fragment from the *Neobolus*-beds of the Khewra Gorge, natural size.

7. **Phyllopora haimeana**, Koninck, p. 799. Small fragment of a colony from the middle region of the middle Productus-limestone of Katta: 7*a*, poriferous side, natural size; 7*b*, the same enlarged; 7*c*, non-poriferous side, natural size; 7*d*, the same enlarged. (See also Pl. XCV, fig. 1, a copy of Mons. de Koninck's figure, for comparison.)

SALT-RANGE FOSSILS.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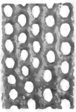
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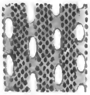
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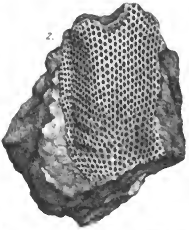
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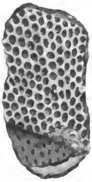
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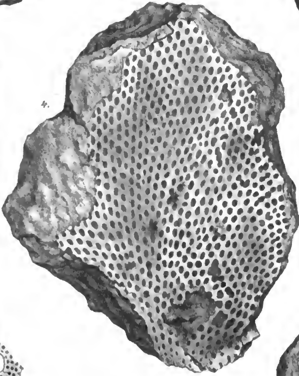
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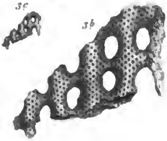
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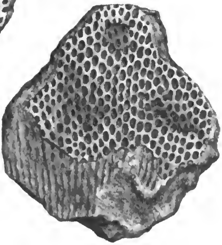
3b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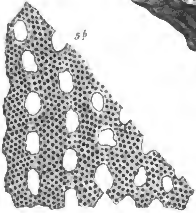
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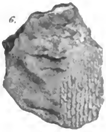
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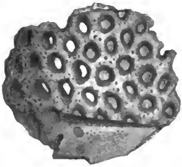
7d

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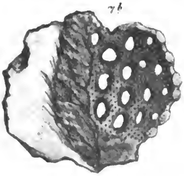

7b

A Swoboda del et lith
Th Bannwarth print

PLATE XCII.

PRODUCTUS-LIMESTONE.

Figure

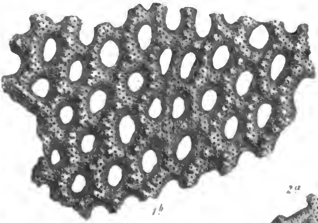
1. **Phyllopora jabiensis**, Waagen & Pichl, n. sp., p. 797. Fragment of a colony from the *Cephalopoda*-bed of the upper Productus-limestone of Jabi: 1*a*, poriferous side, natural size; 1*b*, the same enlarged; 1*c*, non-poriferous side, natural size; 1*d*, the same enlarged.

2, 3. **Phyllopora cribellum**, Konnick, p. 798. 2, a nearly entire colony, showing the external or non-poriferous side, the root being broken off, from the middle Productus-limestone of Morah: 2*a*, natural size; 2*b*, part of it enlarged, showing the granulated surface of the basal plate. 3, Fragment of a colony, partly silicified, showing the non-poriferous side; from the *Cephalopoda* bed of the upper Productus-limestone of Jabi: 3*a*, natural size; 3*b*, part of the same specimen prepared to show the poriferous side, natural size; 3*c*, the same enlarged; 3*d*, non-poriferous side of the same fragment, natural size (the fenestrules slightly too small); 3*e*, the same enlarged, showing the capillary tubes after the removal of the granulated surface.

4. **Synocladia virgulacea**, Phillips, p. 802. Fragment of a colony taken from the vicinity of the root and showing therefore somewhat thickened branches, non-poriferous side; from the middle Productus-limestone of Morah. 4*a*, natural size; 4*b*—*e*, fragment taken from the same specimen and prepared as to show the different sides; 4*b*, natural size, non-poriferous side; 4*c*, the same enlarged; 4*d*, poriferous side, natural size; 4*e*, the same enlarged.

SALT-RANGE FOSSILS.

1c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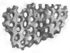
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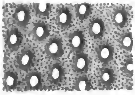
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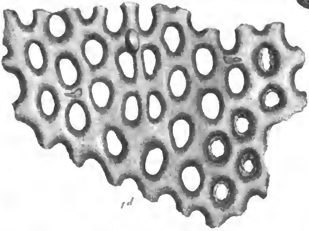
2a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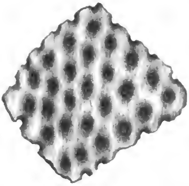
3d

3b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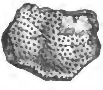
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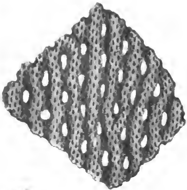
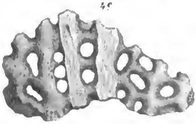
3c



4b

4d

4c



4a

4e

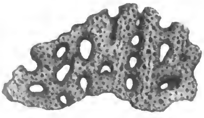


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PLATE XCIII.

PRODUCTUS-LIMESTONE.

Figure 1, 2. SYNOCLADIA VIRGULACEA, Phillips, p. 802. 1, fragment of a colony showing the non-poriferous side; from the upper Productus-limestone of Jabi: 1*a*, natual size; 1*b*—*e*, fragment of the same specimen, prepared to show the different sides; 1*b*, poriferous side, natural size; 1*c*, the same enlarged; 1*d*, non-poriferous side, natural size; 1*e*, the same enlarged, the branches being much worn down; 1*f*, part of the same specimen enlarged, to show the branches in a perfectly preserved condition. 2, fragment taken from the peripheral parts of a colony, showing the non-poriferous side, natural size; from the *Cephalopoda*-bed of the upper Productus-limestone of Jabi.

3. GONIOCLADIA INDICA, Waagen & Pichl, n. sp., p. 805. Fragment of a colony, showing the non-poriferous side; from the middle Productus-limestone of Káfirkót: 3*a*, natural size; 3*b*—*e*, fragment of the same specimen, much broken and shattered, prepared to show the two sides; 3*b*, poriferous side, natural size; 3*c*, the same enlarged; 3*d*, non-poriferous side, natural size; 3*e*, the same enlarged. The basal plate has for the most part been removed by weathering, and thus the commencement of the cells and the median plate along which they originate are exposed to view.

4. THAMNISCUS DUBIUS, Schlotheim, p. 808. Two fragments of a colony, showing the poriferous side; from the middle Productus-limestone of Morah: 4*a*, natural size; 4*b*, the same enlarged; the lower part of one of the branches shows the surface well preserved, the remainder is much weather-worn.

SALT-RANGE FOSSILS.

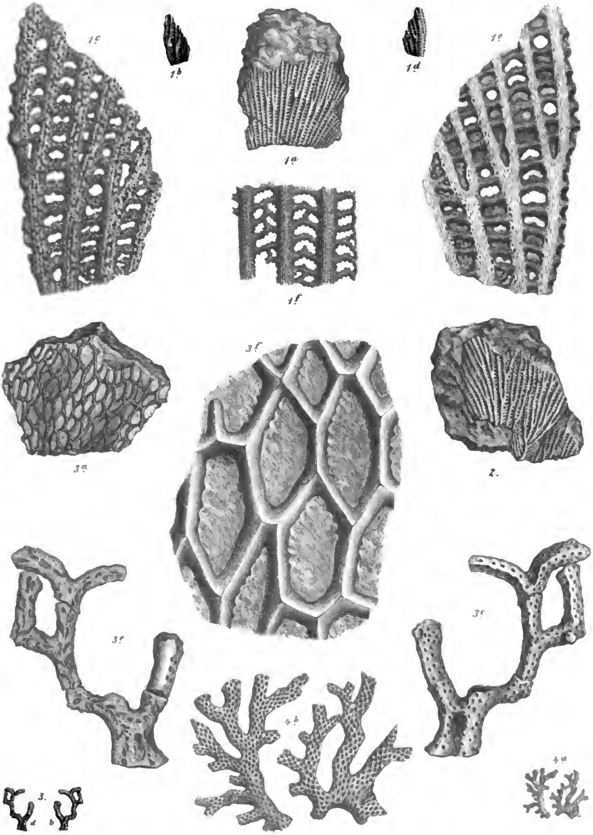

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PLATE XCIV.

PRODUCTUS-LIMESTONE.

Figure 1, 2, 3. ACANTHOCLADIA ANCEPS, Schlotheim, p. 812. Three different specimens, from the middle Productus-limestone of Morah: 1, specimen showing the poriferous side, somewhat deteriorated by weathering; 1*a*, natural size; 1*b*, the same enlarged. 2, a specimen with its root partly preserved, showing the non-poriferous side, the whole much weather-worn, the branchlets chiefly being so much defaced as to expose the pores; 2*a*, natural size; 2*b*, the same enlarged. 3, a fragment prepared to show the poriferous side in a somewhat better condition; 3*a*, poriferous side, natural size; 3*b*, the same enlarged, the branch to the right incrusted at its extremity by a coral; 3*c*, non-poriferous side, natural size; 3*d*, the same enlarged, very much weather-worn.

4, 5, 6. THAMNISCUS SERIALIS, Waagen & Pichl, n. sp., p. 810. 4 & 5, two specimens from the base of the upper Productus-limestone of Khura. 4, a fragment showing the non-poriferous side: 4*a*, natural size; 4*b*, the same enlarged. 5, a strongly weathered specimen, showing a vertical section of the colony: 5*a*, natural size; 5*b*, the same enlarged. 6, a specimen from the middle Productus-limestone of Morah: 6*a*, non-poriferous side, natural size; 6*b*, preparation showing the poriferous side, natural size; 6*c*, the same enlarged. (The figure gives the impression of there being dissepiments; this is, however, not the case in reality, only hardened rock parts that could not be removed have been thus represented by the draftsman.)

7. POLYPORA VERMICULARIS, Waagen & Pichl, n. sp., p. 793. Specimen from the lower Productus-limestone of the Bukh ravine: 7*a*, non-poriferous side, natural size; 7*b*, preparation showing the poriferous side, enlarged; 7*c*, part of the non-poriferous side enlarged.

SALT-RANGE FOSSILS.

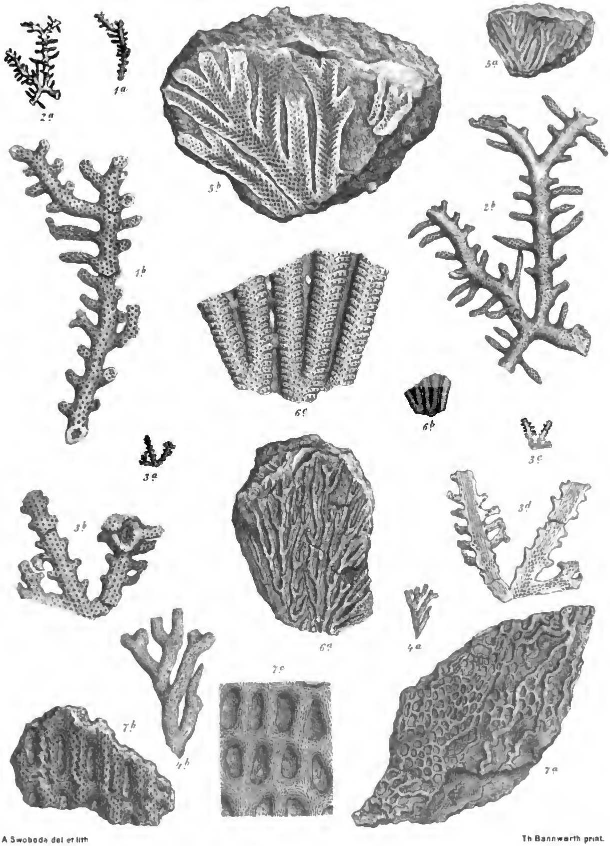

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PLATE XCV.

PRODUCTUS-LIMESTONE.

Figure 1. PHYLLOPORA HAIMEANA, Koninck, p. 799. Copy of Mons. de Koninck's figure in the Quart. Journ. Geol. Soc., Lond., Vol. XIX, pl. 1, fig. 3. (See also Pl. XCI, fig. 7.)

2—3. SPIRORBIS HELIX, King, p. 815. Two specimens from the uppermost beds of the middle Productus-limestone of Kálabágh, adhering to a specimen of *Spirigirella derbyi* W. 2, the larger specimen; 2*a*, natural size; 2*b*, enlarged. 3, the smaller specimen; 3*a*, natural size; 3*b*, enlarged.

4. SERPULITES INDICUS, Waagen, n. sp., p. 817. Fragmentary specimen with partly preserved shell, entirely compressed, from the lower Productus-limestone of Chidru, natural size.

5—16. EOCIDARIS FORBESIANA, Koninck, sp. p. 819. 5, 6, & 7, plates of the body, of different sizes, all silicified; from the middle Productus-limestone: 5, from the Bazáwán; 5*a*, external view; 5*b*, lateral view. 6, from the glen between Chidru and Golawáli, external view. 7, from Katta; 7*a*, external view; 7*b*, lateral view, all natural size. 8 to 16, radioles of different sizes and shapes, all from the middle Productus-limestone and mostly silicified. 8, a fragment (calcareous) from Katta; 8*a*, lateral view; 8*b*, section at the upper end; 8*c*, section at the lower end. 9 and 10, fragments of spines (silicified) from the glen between Chidru and Golawáli, lateral views. 11, a small nearly entire spine, found with the others, with an articulating facet below, from Katta, lateral, lower, and upper views. 12, similar spine somewhat larger, from the glen between Chidru and Golawáli, lateral, lower, and upper views. 13, fragment with the articulating facet preserved, from the same locality as the preceding; 13*a*, front-view; 13*b*, lateral view; 13*c*, section at upper end; 13*d*, articulating facet. 14 & 15, copies of Mons. de Koninck's figures, Quart. Journ. Geol. Soc., Lond., Vol. XIX. pl. 4, figs. 1. 2. 16, rock-fragment from Golawáli, with spines of various shapes. All of natural size.

17—19. PHILOCRINUS COMETA, Koninck, p. 833. 17, a fragment, the upper part of the body only preserved, from the middle Productus-limestone of Bilot: 17*a*, front view; 17*b*, lateral view, showing the *interradiale anale*, both natural size. 18, schematic figure, showing the composition of the body of the species. 19, copy of Mons. de Koninck's figure in the Quart. Journ. Geol. Soc. Lond., Vol. XIX., pl. II, fig. 5.

20. ? PHILOCRINUS COMETA, Koninck, p. 833. Fragments of stems, probably belonging to this species, from the middle Productus-limestone of the mouth of the Bazáwán, natural size.

SALT-RANGE FOSSILS.

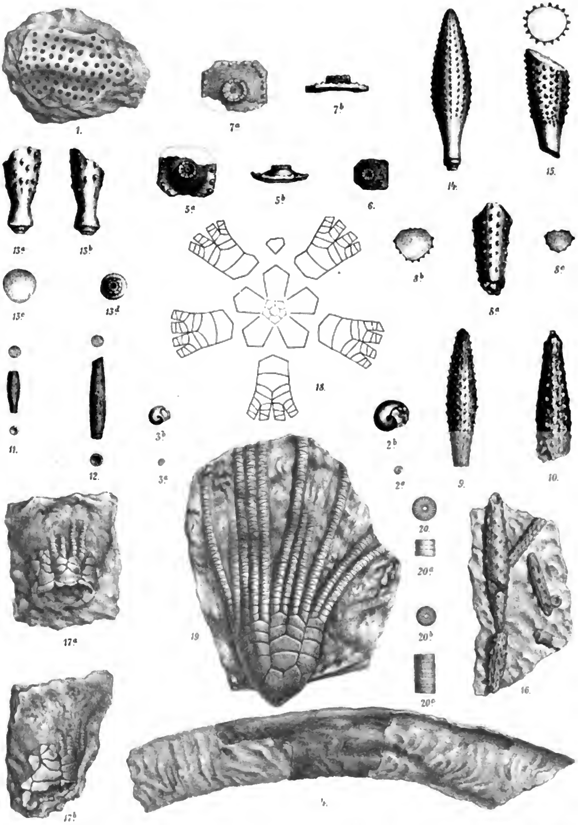

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PLATE XCVI.

PRODUCTUS-LIMESTONE.

Figure 1. Cyathocrinus indicus, Waagen, n. sp., p. 826. Body without the arms, and fragment of the stem; from the lowest beds of the middle Productus-limestone of Nursingpohár: 1*a*, the body, natural size, view from the anal side; 1*b*, the same enlarged; 1*c*, lateral view, enlarged; 1*d*, view from the base, enlarged; 1*e*, *f*, *g*, fragment of the stem; *e* & *f*. enlarged; *g*, natural size; 1*h*, schematic figure, showing the composition of the body.

2. Cyathocrinus kattaensis, Waagen, n. sp., p. 828. Body without the arms, and fragment of the stem; from the lowest beds of the middle Productus-limestone of Katta: 2*a*, the body, anal view, natural size; 2*b*, the same enlarged; 2*c*, lateral view, enlarged; 2*d*, other lateral view enlarged; 2*e*, view from the base, enlarged; 2*f*, *g* & *h*, fragment of the stem; *f* and *g*, enlarged; *h*, natural size; 2*i*, schematic figure to show the composition of the body.

3, 4, 5. Hydriocrinus, (?) sp., p. 830. Fragments of stems: 3, from the top-beds of the upper Productus-limestone of Virgal; 4 & 5, from the upper Productus-limestone of the hills east of Katwahi. Naturál size.

6—12. Cyathocrinus ooliathus, Waagen, n. sp., p. 823. Fragments of the body and of the stem from the Crinoid-beds of the middle Productus-limestone of Virgal: 6 & 7, *Parabasalia* of different sizes and shapes, external, internal and lateral views; 8, *Radiale*; 8*a*, external, 8*b*, internal, 8*c*, lateral view; 9, *Interradiale anale?*; 9*a*, external, 9*b*, lateral view; 10, articulating facet of the stem; 11 & 12, fragments of stems. All natural size.

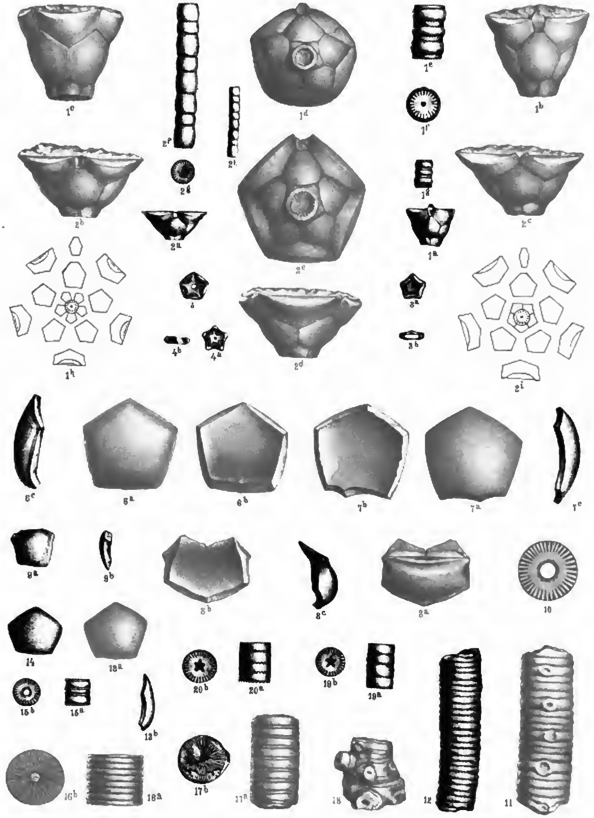
13, 14, 15. Cyathocrinus virgalensis, Waagen, n. sp., p. 825. Fragments of the body and of the stem from the crinoid-beds of the middle Productus-limestone of Virgal; 13 & 14, *Parabasalia*, external and lateral views; 15, stem fragment. All of natural size.

16, 17, 18. Poteriocrinus? sp., p. 831. Fragments of stems: 16 & 18, from the *Cephalopoda*-bed of the upper Productus-limestone of Jabi; 17, from the middle Productus-limestone of Morah; natural size.

19, 20. Poteriocrinus? sp., p. 831. Fragments of stems: 19, from the middle Productus-limestone of Katta; 20, from the top-beds of the middle Productus-limestone of Khura; natural size.

Geol. Surv. of India. Pl. XCVI.

SALT-RANGE FOSSILS.



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Th Bannwarth print

PALÆONTOLOGIA INDICA.

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BEING

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PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. XIII. SALT-RANGE FOSSILS

by **WILLIAM WAAGEN, Ph.D., F.G.S.,**

Professor of Mineralogy and Geology at the I. R. German Polytechnic University of Prag.

I. PRODUCTUS-LIMESTONE FOSSILS:

6. CŒLENTERATA.

WITH PLATES XCVII—CXVI.

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Sub-Kingdom: **CŒLENTERATA.**

(By William Waagen and Joseph Wentzel, Assisant.)

Class: ANTHOZOA.

Order: ZOANTHARIA.

Sub-order: HEXACORALLA.

Family: *PORITIDÆ*, Dana.

In commencing the description of the *Cœlenterata* it must be remarked that the greater and most troublesome part of the work, the preparation of the materials for microscopical inspection and the arrangement of the plates have been done by Mr. Wentzel, whilst the part taken by Dr. Waagen in the work was restricted chiefly to superintending Mr. Wentzel's labours, and writing the whole work.

Mr. Wentzel took the utmost pains to arrive at fair results, and the microscope slides he prepared for the purpose amount to several hundreds. It is obvious that for such preparations a very long time was needed, and thus there have elapsed nearly three years since the work was begun. A very great advantage of this was, that it was thus possible to select out of the hundreds of slides the specimens suited for representation on the plates, and to get thus really instructive figures.

It must be stated also with thankfulness that Mr. Swoboda spared no pains in representing the often very complicated microscopic objects as correctly and distinctly as possible.

Among the *Cœlenterata* the class of the *Anthozoa* most needs to be considered in detail, and it is largely represented among the palæozoic fossils of the Salt-range. Two orders are present, the *Zoantharia* and the *Alcyonaria*, though the forms we place in the latter have not generally been considered as such.

The *Zoantharia*, so far as they are provided with a solid skeleton, which alone furnishes materials for the palæontologist, can very conveniently be brought into two sub-orders: the *Hexacoralla* and the *Tetracoralla* or *Rugosa*, the other subdivisions as proposed by Edwards and Haime being no longer tenable.

Up to very recent times the *Hexacoralla* have been considered as restricted to the mesozoic formations; only recently, after the affinity of the *Favositidæ* and the *Poritidæ* had been proved beyond doubt, it has been shown that the *Hexacoralla* also reach down far into the palæozoic era.

The *Poritidæ* form as yet a rather large assemblage of forms, having but few characters in common. Zittel in his handbook includes even the whole of the

Favositidæ in the family, but in this respect we prefer to follow the indications given by Nicholson, according to which the *Favositidæ* form a family by themselves. But even after the separation of the *Favositidæ*, the *Poritidæ* still contain so many forms that it is difficult to give a general characteristic of the family.

The most widespread character seems to be the perforated condition of the walls of the corallites. These walls are not perfectly compact, but to a certain extent spongy, and pierced by a more or less large number of mural pores. In the specimens accessible to our observation the primary mural plate cannot be distinguished, the whole wall from one side to the other forming one spongy mass. The septa are generally well developed, but not numerous, partly more or less trabecular. Sometimes large masses of cœnenchyma are intercalated between the corallites. Tabulæ are only exceptionally present. The corallum always forms a massive compact body.

After the *Favositidæ* have been separated from the family, there still remain three sub-families within it, according to Zittel's handbook. All three are very easily distinguishable. The first is the—

Sub-family: *TURBINARIINÆ*, E. & H.

which is characterized by a spongy cœnenchyma, intercalated between the single polypites. The family is chiefly composed of tertiary and recent genera, only some of them are palæozoic, like ***Prisciturben***, Kunth, ***Palæacis***, E. H., &c. The second is the—

Sub-family: *PORITINÆ*, E. & H.

Also in this sub-family mostly recent and tertiary forms are comprised; but a greater number of mesozoic and palæozoic genera occur in it than in the preceding sub-family. Its chief characteristic consists in the almost entire absence of a cœnenchyma. In this respect it agrees with the next following sub-family, the ***Alveoporinæ***, but is distinct from it by the absence of tabulæ.

As regards the genera quoted by Zittel in this sub-family, we must remark, that ***Pleurodictyum***, Gdf., is certainly wrongly placed, as it is a genus most nearly related to, if not identical with, ***Michelinia***, Kon., and so must be removed to the family ***Favositidæ***. The third, the—

Sub-family: *ALVEOPORINÆ*,

is of special interest to us, as it is represented in the Salt-range. The characters of the sub-family are very easily framed. The most characteristic feature consists in the existence of more or less completely developed tabulæ, which, together with the spongy condition of the walls and the presence of trabecular septa, makes a recognition of the genera belonging to it not very difficult. To these characters can be added the inter-mural gemmation of the corallites, that is to say, the propagation takes place by the wall between two adjoining polypites splitting into two parts, between which a new young polypite is formed. The full definition of this mode of propagation will be given in the introduction to the *Monticuliporidæ*. This mode of augmentation has been figured very clearly by Quenstedt in *Alveopora* (Petrefact. Deutschl.: Koraller, pl. 184, fig. 69 L).

The genera quoted by Zittel as belonging to the sub-family are—

Goniopora, Quoy and Gaimard (recent).
Koninckia, Edwards and Haime (cretaceous).
Favositipora, Kent (recent).
Alveopora, Quoy and Gaimard (recent and tertiary).

To these must be added, according to our view, *Aræopora*, Nicholson, though it has not been so placed by this author. We shall treat more in detail of the systematic position of the genus in the following description.

It is the only genus representing the sub-family in the Salt-range; there are two species.

Sub-family: *ALVEOPORINÆ*, Verrill.

Genus: ARÆOPORA, Nicholson.

The genus was defined by Nicholson in 1879 in his work on the "Tabulate Corals." The characteristic given is as follows:—

"Corallum massive, Favositiform, of polygonal corallites, which radiate outwards from an imaginary axis to open upon the free surface of the colony. Under-surface covered by an epitheca (?). The corallites are firmly united by their walls, which are extensively perforated by apertures, which place the visceral chambers of contiguous tubes in direct communication. Septa trabecular, often irregularly divided, or anastomosing at their free ends. Tabulæ rudimentary, represented only by occasional horizontal trabeculæ. No columella, nor cœnenchyma."

We have made several microscopical preparations of one of the species occurring in the Salt-range, the preservation of which was such as to promise fair results, and from these sections it appears that the characteristic of the genus must be changed to a certain extent in some points to fit the Salt-range species.

No mention is made by Nicholson of the spongy condition of the walls of the corallites, which is a very peculiar character. Generally the walls of the corallites consist of the so-called "primary mural plate," the dark or light coloured line (according to preservation) that in tangential sections forms the middle-line of the walls, and which is followed on both sides by secondary thickening, whereby the wall properly speaking is produced. This primary mural plate is absent in *Aræopora*, at least we could not detect it in any of the sections we made, the whole thickness of the walls of the corallites being made up of a spongy mass, which is often of very considerable thickness, but varies to a great extent in this respect.

The mural pores pierce this spongy mass at very irregular distances, but seem to be on the whole rarer in the Indian than in the Australian species. They bend most irregularly in all directions, thus forming tortuous canals, which often assume the appearance of intermural canals, as they have been defined by Nicholson. In fact these latter organs are probably in all cases nothing else but the canals of irregularly bending mural pores, as we shall have occasion to show later on in this work.

Another point which has to be rectified is the condition of the tabulæ. They are well developed and quite distinct, not rudimentary, in the Indian species.

A point which has been rightly divined by Nicholson is the existence of an epitheca, which is clearly exhibited by our specimen figured on pl. XCVIII.

The propagation, or gemmation, is an intermural one, as may be seen from figs. 3*a* and *b* on Pl. XCVIII.

The genus has been compared by Nicholson to the more massive species of ***Favosites***, like ***Fav. hemisphærica***, Yand. and Shum., or more particularly to ***Columnopora***, Nich., which is said to possess similarly porous walls of the single corallites.

On p. 32 of Nicholson's Tabulate Corals, however, the genus is also compared to ***Alveopora***, which seems to us to express more appropriately the real affinities of the genus than the comparison with ***Favosites*** and the like.

If we consider the figures given by Nicholson on Pl. VII of his work, we see immediately that the walls of the corallites in ***Columnopora*** are entirely different in their structure from ***Aræopora***, though they may be similarly perforated. But in the tangential sections, figs. 2*a* and *c*, we see very distinctly a primary mural plate and the otherwise compact condition of the wall. There is not a trace of the spongy matter, nor the absence of the primary mural plate, as in ***Aræopora***.

In this respect ***Aræopora*** deviates from all the rest of the ***Favositidæ***, and therefore we have thought it proper to remove it altogether from that family. The spongy condition of the walls of the corallites seems to approach ***Aræopora*** more nearly to the family ***Poritidæ*** than to any other group of corals, whilst the existence of distinct tabulæ and the trabecular development of the septa indicate a certain affinity of the genus to ***Alveopora***, an affinity that has also been recognised by Nicholson. Thus, it cannot be very wrong if we place the genus in the sub-family ***Alveoporinæ***. The only doubt that might remain is, whether the genus should not perhaps be better considered as forming a sub-family by itself.

The genus has up to the present only been found in Australia (Queensland), in beds of a doubtfully devonian age. The Indian specimens are met with in much more recent strata, but though two species can be distinguished, yet both are very characteristically different from the ***Aræopora australis*** as described by Nicholson, as might indeed be supposed from their different geological position.

1. ARÆOPORA TUBEROSA, Waagen & Wentzel, Pl. XCVIII.

The species forms massive corals of moderately large dimensions, which, on the whole, have a more or less roundish tuberous appearance. They may have been fixed to some foreign body by part of the under-surface, but the specimens at our disposal do not show this clearly. The whole upper surface and part of the lower one are covered with the closely arranged calices, whilst in places along the margins of the colony a thin concentrically plicated epitheca is developed, which is, however, much worn by weathering. The single corallites all radiate from an imaginary short axis or centre of the colony, but are otherwise rather irregularly arranged, bending in various directions. The calices are on an average about 2mm. in diameter, but on the whole very irregular in size and shape. There are always small calices of young animals disseminated between larger ones. The irregular trabecular septa can be well seen within the calices. The calices are separated from each other by rather thick walls, on which little pores are irregularly disseminated.

As regards the internal structure, the most strange and characteristic feature, the spongy condition of the walls, has been mentioned already in the description of the genus. The mural pores are not very numerous, are very irregularly arranged, and form, according to the thickness of the walls, narrow canals, which generally bend in various directions, and are thus more often cut transversely by thin sections, forming round holes somewhere within the substance of the walls, than longitudinally piercing the wall from one end to the other. The trabecular septa are of such an excessive irregularity that, in thin sections, they sometimes appear quite separated from the wall, which is caused by their bending upward and extending to near the middle of the tube of the corallite as tooth- or thorn-like projections. The tabulæ are complete, not very numerous, much more regular than the walls, and mostly bending upward.

Locality and geological position.—This is a very rare species; there is only a single specimen of it preserved among the Salt-range materials. It comes from Dr. Verchere's collection, and was certainly found somewhere in the Rotta Roh range, though the exact locality is not known. The specimen is entirely calcareous, and comes beyond doubt from the middle division of the Productus-limestone.

Remarks.—In general appearance the species seems to be rather nearly related to *Aræopora australis*, Nich., as the latter has likewise a tuberous or pyriform shape. On a close examination the distinction of the two forms is, however, very easy. The Indian species appears to be much clumsier in its general appearance, the walls of the corallites are thicker, and if thin slides are examined with the microscope it is found to possess perfect tabulæ, whilst these are imperfect in *Aræop. australis*.

These characters suffice to distinguish between the two species. There is no other form to which the present one could be compared, except the following:—

2. ARÆOPORA RAMOSA, Waagen & Wentzel, Pl. CVI, figs. 8-9.

Corallum massive, arborescent, probably attached with its base to foreign bodies. The branches are thick, up to a diameter of 50 to 70mm., but generally much thinner (about 30-40mm). The branching is regularly dichotomous. The branches are generally not round but laterally compressed, so as to have an oval section; they are also not quite straight, but variously bent and twisted. The corallum seems to have grown to a large size; but there are only fragments preserved in the Salt-range collection, so it is impossible to say what dimensions it really attained. It seems not improbable that the entire arborescent colonies may have attained a height of half a metre. There is not a trace of an epitheca on any of the specimens at disposal. The entire branches are composed of very numerous approximately cylindrical or polygonal corallites, which radiate from an imaginary axis, ascending and diverging by degrees. The whole surface of the branches is covered by not very large calices. They are irregularly polygonal or roundish, and of rather unequal size, on an average, however, about 3mm. in diameter, separated from each other by rather thick porous walls. The smaller calices disseminated between the larger ones indicate probably the existence of young corallites. The septa are rudimentary, very irregular, and represented only by thorny processes, extending into the visceral chamber of the corallites.

Of the internal structure of this species we know but very little. All the specimens are preserved in such a manner that it was found impossible to make microscopic preparations. Either the whole specimen is impregnated with silica so that it forms one siliceous mass and nothing can be distinguished, or the visceral chambers of the corallites are filled with sandy matter, and their walls are then brittle to such a degree that it is impossible to make a thin section.

Locality and geological position.—This species is much more common than the preceding one, but it is at the same time restricted to the upper division of the Productus-limestone. It has been found in this geological position by myself west of Khura (4 sp.), at Jabi (1 sp.), and at Chidru (1 sp.), in the Cephalopoda-bed; Mr. Wynne brought the species from Vurcha (1 sp.), from the Bazárwán (1 sp.), from Jabi (1 sp.), and from Chidru (1 sp.).

Remarks.—Though the microscopical inspection of this species has failed, yet there cannot be any doubt that the form here under consideration is congeneric with the preceding one; the spongy condition of the walls of the corallites can be seen in it, even on weathered surfaces.

Also specifically the present species seems to be very nearly related to the preceding one. It differs, however, from the latter by the arborescent shape of the corallum, and also apparently by, on an average, somewhat larger calices, though it is rather difficult to decide on this point, as the size of the calices is so very variable.

On the whole, it is highly probable that we have to deal here with a separate species, as not only there exist differences between the two forms, but also the geological positions of the two are different, *Aræop. tuberosa* being restricted to the middle, and *Aræop. ramosa* to the upper division of the Productus-limestone.

Family: *FAVOSITIDÆ*, Nicholson.

The family has been characterised by Nicholson in the following manner:—

"The corallum in this family is of very variable form, but is composed of polygonal or sub-cylindrical corallites, which are usually in close contact throughout their entire extent, and are furnished with well-developed walls. The walls are, however, perforated by a greater or smaller number of rounded apertures—the mural pores—by which the visceral chambers of contiguous polypites are placed in direct communication. There is no true cœnenchyma; and the condition of the septa is extremely variable, these structures being sometimes obsolete (some forms of *Trachypora*, &c.), sometimes in the form of marginal lamellæ or ridges (*Nyctopora*, Nich.), and most commonly represented by vertically disposed rows of spinules (most species of *Favosites*). The tabulæ are usually well developed and complete, but they are sometimes imperfect (*Favosites hemisphærica*, Yand & Shum.)"

To this admirably clear characteristic of the family nothing has to be added. The distinction of the family from the *Poritidæ* appears on a first glance to consist in the perfect walls of the single corallites in the *Favositidæ*, where each single individual has its proper, perfectly developed wall, whilst the line of junction, where the walls of two adjoining corallites are united, forms what is generally called "the primary mural plate," or "primordial wall." This plate appears rather differently in different specimens, according to preservation, and even in one and the same specimen its appearance is often very different. Mostly it can be seen under the microscope as a dark or even black line, separating the walls of adjoining corallites, but often this dark line is replaced by a light-coloured one, and then its distinction is often so vague that it appears as if the two adjoining walls were perfectly united and grown together without distinction. This latter appearance depends, however, solely upon the preservation. Lastly, a third mode of appearance is brought about by the primordial wall being preserved partly as dark, partly as light-coloured substance, whereby it then appears as a series of black points.

The secondary thickenings of the walls of the corallites in the *Favositidæ* are built up of transversely arranged fibres.

The propagation, or gemmation, of the *Favositidæ* is an intermural one; that is to say, in that part of the soft animal matter covering the outside of the whole corallum, and, corresponding to the primary mural plate of the calcareous parts, a new individual takes its origin. It is formed by gemmation on the outskirts of one of the adjoining individuals, and when the calcareous wall begins to be formed, the primary mural plate, extending between the two old individuals, is caused by this new one to split in two and thus to make room for the new intruder. As the whole process of gemmation is thus restricted to the soft parts of the colony, and the calcareous parts only take part in the process after the new individual has already been separated from the old one, it is very natural that it afterwards becomes impossible to say from microscopical inspection of the calcareous corallum alone from which of the two adjoining old individuals the new one took its origin. All that has been said of the soft parts is, as may be supposed, purely hypothetical, but it is the only way of explaining the fact that it is never possible to say from which individual a new one may have taken its origin. In the description of the *Monticuliporidæ* we shall have occasion to recur to this subject.

Another mode of propagation that also occurs in the *Favositidæ* is that of simple fission of an old individual by splitting in two (fissiparity). A vertical wall begins to be formed on one side of an individual, stretching forth into the visceral cavity and by and by dividing it into two. This mode of propagation is, however, rather rare; only in the genus *Cœnites*, Eichw. it seems to be the rule.

The number of forms belonging to the family *Favositidæ* is rather large. In Zittel's handbook, we find not more than eight genera enumerated within the family, other genera which must now be included in the family being put into the family *Pocilloporidæ*, or partly even among the *Bryozoa*.

The knowledge of the family has been enormously extended by the investigations of Prof. Nicholson. He enumerates not less than 24 genera within the family of which, however, not all can be retained in it. According to what has been said with regard to the preceding family (the *Poritidæ*) the genera *Favositipora*, Kent., and *Aræopora*, Nich., must be the first excluded. Then also *Stenopora*, Lonsd., cannot, according to our investigations, be retained in the family *Favositidæ*, but must be removed to the *Monticuliporidæ*.

There will still remain not less than about nineteen genera, which with more or less certainty belong to the family.

Nicholson himself has already given some hints as to a grouping of the genera, and chiefly one group of forms he circumscribes more in detail; this is the one composed of the genera *Pachypora*, Lindst., *Striatopora*, Hall, *Trachypora*, E. & H. *Dendropora*, Mich., and *Cœnites*, Eichw. Another group seems, according to him, to be constituted by *Syringolites*, Hinde, and yet another one by *Nyctopora*, Nich. We cannot in all these respects agree with Mr. Nicholson. The genus *Nyctopora* is separated from the remainder of the *Favositidæ* by the circumstance that in this genus the primary mural plate, generally so conspicuous in the genus *Favosites*, is not distinguishable. If one considers, however, in what large degree the distinctness of this primary mural plate depends upon the mode of preservation of the specimens, it may perhaps be prudent to separate the genus *Nyctopora* for the moment, yet not entirely, from *Favosites* by putting it in a quite different division of the family. The propriety of separating *Pachypora* and allied genera from *Favosites* may also be questioned, as recently Mr. Frech has even opposed the idea of considering the two as different genera; but that this can be done quite safely we shall have occasion to show presently. Mr. Nicholson's grouping of *Pachypora* and allied genera in opposition to *Favosites*, etc., may however be accepted for the present, though it cannot be denied that *Pachypora* and *Favosites* are very near relations.

On the whole, it appears to us that very conveniently five sub-families may be distinguished within the family *Favositidæ*.

I. Sub-Family: *FAVOSITINÆ.*

In the genera belonging to this sub-family the corallites mostly have thin walls, and (mostly) complete, straight, not cystoid tabulæ. We consider the following genera as belonging to it.

1. **Favosites**, Lam., 1816: Hist. des Anim. sans Vert., vol. II, p. 204. Silurian to carboniferous. As a sub-genus there might, perhaps, be retained **Emmonsia**, E. & H. 1851: Pol. Foss. des Terr. paléoz.
2. **Romingeria**, Nichols., 1879: Tabulate Corals, p. 114. Devonian.
3. **Vermipora**, Hall, 1874: Twenty-sixth Ann. Rep. State Cab. of New-York, p. 109. Silurian and devonian.
4. **Nyctopora**, Nichols., 1879: Tabulate Corals, p. 182. Lower silurian.
5. (?) **Nodulipora**, Lindström, 1873: Ofversigt af Kongl. Vetensk. Akad. Forhandlingar, No. 4, p. 14, note. Upper silurian. (The position of this genus is uncertain.)
6. (?) **Billingsia**, Koninck, 1876: Rech. Foss. Paléoz. de la Nouv. Galles du Sud, I. p. 75, Pl. II, fig. 4. Devonian (position uncertain).

II. Sub-Family: *TRACHYPORINÆ.*

This sub-family is characterised by having the walls of the corallites very much thickened on the inside. The tabulæ are complete, straight, not very numerous. The following genera may be considered as belonging to it.

1. **Pachypora**, Lindström, 1873: Ofversigt af Kongl. Vetensk. Akad. Forhandlingar, p. 14. Silurian to permian.
2. **Striatopora**, Hall, 1882: Palæont. of New-York, vol. II, p. 156. Upper silurian and devonian.
3. **Trachypora**, E. & H., 1851: Polyp. Foss. des Terr. Paléoz, p. 305. Devonian.
4. (?) **Laceripora**, Eichwald, 1860: Leth. Rossica, p. 490. Silurian (?) and carboniferous (?) (position uncertain).

III. Sub-Family: *MICHELINIINÆ.*

In the genera belonging to this sub-family the walls of the single corallites are thin, and often much perforated. The tabulæ are numerous and strongly cystoid. Calices generally large. The genera belonging to it are the following:—

1. **Columnopora**, Nichols., 1874: Geolog. Mag., new ser., Vol. I, p. 253, fig. 1. Silurian.
2. **Michelinia**, Koninck, 1842: Anim. Foss. des Terr. Carb. de la Belgique, p. 29. Silurian (?) and carboniferous.
3. **Pleurodictyum**, Goldf., 1829: Petrefact. Germ., I, p. 113. Silurian (?) and devonian. (Perhaps identical with the preceding.)
4. **Chonostegites**, E. & H., 1851: Polyp. Foss. des Terr. Paléoz., p. 299. Devonian. The position of this genus is very doubtful. It possesses a stolonal gemmation, and thus should perhaps be considered as belonging to the *Alcyonaria*.
5. (?) **Beaumontia**, E. & H., 1851: Polyp. Foss. des Terr. Paléoz., p. 276. Devonian and carboniferous (position uncertain).

IV. Sub-Family: *SYRINGOLITINÆ.*

The few genera that compose this sub-family are characterised by the thin walls of the corallites and funnel-shaped tabulæ, which touch each other in the middle and thus form a central tube.

There are only two genera which possibly might be placed in this sub-family:

1. SYRINGOLITES, Hinde, 1879: Geolog. Mag., Dec. II, vol. VI, p. 244. Silurian.
2. (?) ROEMERIA, E. & H., 1851: Polyp. Foss. des Terr. Paléoz., p. 253. Devonian (position very uncertain).

V. Sub-Family: *ALVEOLITINÆ.*

The forms belonging to this sub-family are characterised by corallites which are not strictly cylindrical or polygonal, but more or less compressed, triangular, or semilunar in the transverse section. The walls of the corallites are sometimes thickened, sometimes not. Septa mostly rudimentary, sometimes one or two slightly indicated.

There are, as it seems to us, only two genera belonging to this sub-family:

1. ALVEOLITES, Lam., 1801: Syst. des Anim. sans Vert. p. 375. Silurian and devonian.
2. CŒNITES, Eichw., 1829: Zool. special, t. I. p. 179. Silurian and devonian.

The family *Favositidæ* is but sparingly represented in the Salt-range. Only two genera belonging to it are in the collection, and even these are not very common.

The genus *Pachypora* is represented by two species, whilst the genus *Michelinia* appears with more massive forms, taking part in the composition of the coral-reefs which occur off and on in the middle region of the Productus-limestone. This latter genus has furnished four species.

Sub-Family: *TRACHYPORINÆ.*

Genus: PACHYPORA, Lindström.

The available materials of this genus from the Salt-range were very scanty, and only of one species a sufficiently large piece was at our disposal for microscopical sections. These, however, prove to be very instructive, and elucidate many points, the discussion of which is of interest.

Regarding the generic position of these specimens, there seems to us even some slight preliminary doubt as to whether we have to deal here with a true *Pachypora*. The distinction of *Pachypora* from *Favosites* seems to be not in all cases easy, and it has been advocated by Frech that the two genera should be considered entirely identical. The reasons brought forward by Dr. Frech are beyond doubt well founded for the case he treats of, but we should not like to generalise the question so far as he does. Before all it seems to us that the genus *Pachypora* is not founded solely on the thickening of the walls of the single corallites, though this is the most striking character, but the distinction rests also in the larger and more irregularly distributed mural pores in *Pachypora* than is generally to be observed in *Favosites*. Thus, in some species of *Favosites*, although the walls of the corallites may sometimes become thickened, this does not seem to us a sufficient reason for uniting all species of *Pachypora* with *Favosites*.

These special characters of *Pachypora* are very well exhibited by the microscopical sections we have represented on Pl. XCVII: that not only the thickened walls of the corallites are most distinctly developed, but also the characters of the mural pores can be very well distinguished. The large size of them is on a first glance very remarkable, and as regards their distribution, we see in all the figures that this is very irregular, and in figure 3*b* that some corallites show a biserial, others a uniserial, arrangement of these pores. From this it appears that we have certainly to deal in this case with a true *Pachypora*.

All the sections are, however, taken from one species. With regard to the other species occurring in the Salt-range, we cannot say anything definite. We place it in the genus *Pachypora* only on account of its outward appearance.

Of other interesting points observable in the sections the condition of the primary mural plates may be particularly mentioned. We see in the figures on Pl. XCVII that the appearance of these organs is very different according to different modes of preservation. In the Figs. 1*c*, 3*a*, and 3*b* the primary mural plates separating the single corallites and forming the middle line of the thickened walls, appear as dark lines, mostly distinctly defined, sometimes however rather diffuse. In fig. 3*c*, on the contrary, the primary mural plates appear as white lines with darker margins. These margins are absent in the lower part of the same figure, and the primary mural plate is represented only by a light-coloured zone. We must lay some stress on these different modes of preservation of the primary mural plates, as in the *Monticuliporæ* similar phenomena are very often to be observed, and it is of importance to find the same facts in *Pachypora*, an undoubted coral.

Another fact which requires some words of explanation is the mode of appearance of the mural pores in the different preparations represented on Pl. XCVII. In this respect chiefly fig. 3*a* is very instructive. We see that the mural pores are the entrances to long tortuous canals, one or the other of which often bends in such a way that it terminates suddenly with a round pore, as always happens when the canal is cut by the thin microscopical slide transversely, instead of longitudinally. Quite the same can occur also in tangential sections; then we have round pores within the substance of the wall, assuming the appearance as if a vertical canal extended within the wall, an appearance which perfectly agrees with what has been called by Nicholson "intramural canals." It appears to us highly probable that Mr. Nicholson s intramural canals are nothingelse than such tortuous mural pores which happened to be cut transversely, instead of longitudinally, in some of his microscopical sections.

The intermural gemmation, or propagation, of these forms can also be well observed in the thin sections represented on Pl. XCVII, figs. 3*a*, *b*, *c*, and 1*c*.

As has been stated above, the genus is represented in the Salt-range by two species, which are both new to science. They were found in one and the same bed, in the Cephalopoda-bed of the upper Productus-limestone at Jabi.

1. PACHYPORA CURVATA, Waagen & Wentzel, n. sp., Pl. XCVII, figs. 1 & 3.

The corallum is massive, forming apparently simple, undivided stems, more or less round in section. These stems do not become very thick, their maximum diameter is about 10mm. The corallites are numerous, of very unequal size, their orifices forming round pores of never more than one millimetre in diameter on the surface of the stems, and covering this surface entirely. The walls of the corallites are quite enormously thickened, and this nearly for their entire extent. This thickness of the walls causes the calices to be rather far apart from each other. The space between is carinated in the middle. The corallites take their origin in the middle of the stems, and radiate in ascending, slowly at first and then rather suddenly bending round towards the surface of the stems. Of septa properly speaking nothing can be observed; they are apparently replaced by the so-called septal spines, which are exceedingly strongly developed in the present species, but can be observed only on thin sections. Tabulæ are of extremely rare occurrence.

Locality and geological position.—There is a single specimen of this species contained among the materials from the Salt-range. This was collected at Jabi in the Cephalopoda-bed of the upper Productus-limestone.

Remarks.—This is one of the most typically developed species of *Pachypora* imaginable. It is distinct from all the species hitherto described, by the extreme scarcity of tabulæ. So much the more are the so-called septal spines developed, and it might even be questioned whether in this case these spines ought not rather to be considered partly as incomplete tabulæ. They are extremely irregular, bending in every direction and often uniting from opposite sides of the corallite.

Of previously described species chiefly *Pachypora nicholsoni*, Frech. (=*Pachyp. cervicornis* (Blainv.) Nichols.), from the devonian of the Eifel, may be compared; it needs only a look at Nicholson's excellent figures to see how closely the two forms are related to each other. Of identity there can, however, be no question, as the Indian species has very considerably larger calices than the devonian one.

Another species which perhaps might be compared is *Calamopora mackrothi*, (Gein.) King. If Mr. King's indications with regard to this form are right, and we have not any reason to doubt them, then the above name cannot stand, as *Stenopora mackrothi*, Geinitz, is something quite different from what has been described by King under the name. Then the species will have to be called *Pachypora ? independens*, King (1848, Catalogue, p. 6). It is probably a *Pachypora*, though we cannot be sure on the matter, as we have no materials of the species; but if so, it seems to be rather nearly related to our *Pach. curvata*. It is a ramose species, like the Indian one, but the corallites seem also to be on an average smaller, and thus the similarity is only a rather distant one.

2. PACHYPORA JABIENSIS, Waagen & Wentzel, n. sp., Pl. XCVII. fig. 2.

Our only specimen, and that a small one, of this species is very perfectly preserved; and though, owing to the scantiness of the material, we were not in a position to make thin sections, yet most of the characters of the species can be made out.

The corallum is massive, not very large, of an irregularly tuberous shape, taking rise from the edge and both faces of a small shell fragment. The whole surface is covered with the calices of the single corallites, which are very irregular in size, more or less polygonal in shape, and never possessing a diameter of more than 1·5mm. These calices are separated from each other by rather thick walls, with high sharp crests in the middle.

The interior of the corallites is partly exposed for a certain distance, the strong matrix having been removed out of them by weathering. It can thus be seen that the walls have extremely large, irregularly arranged, mural pores, and that the inside of the walls is ornamented at irregular distances by rounded protuberances, which assume somewhat the appearance as if the corallites were provided with irregular septa.

The mode of augmentation of the corallites can also be well observed. Both the modes of propagation described in the introduction to the family as occurring in the *Favositidæ* are represented on our specimen. Generally the mode of gemmation is the intermural one, but in one or two cases very distinctly fissiparism can be made out.

Locality and geological position.—The single specimen of this species existing in the Salt-range collection was found in the Cephalopoda-bed of the upper Productus-limestone of Jabi.

Remarks.—The position of this species in the genus *Pachypora* cannot be considered as above every doubt, until the microscopical inspection of it can be executed. For the present this position seems the most probable one, according to the characters which have been indicated in the above description.

Of species previously described the one quoted by Beyrich as *Calamopora* sp., from carboniferous beds of the island of Timor, must chiefly be compared. In that form the calices are of about the same diameter as in the Indian specimen; they are also polygonal, and thorn-like processes are observable on the inside of the walls of the single corallites here and there. The entire shape of the corallum seems also to be more or less tuberous. An exact identification of this form with the Indian one, however, cannot be made because the mural pores have not been observed in the specimens from Timor.

Other carboniferous species, chiefly those from the mountain-limestone, can barely be compared with the present form. *Favosites haimeana*, Kon., has similarly large cells, but the walls of the corallites are quite thin, and the corallites are very long.

Sub-Family: *MICHELINIINÆ.*

Genus: MICHELINIA, Koninck.

To the excellent characteristic of the genus, as framed by Nicholson, but very little is to be added. All that still needs mentioning is the mode of gemmation, which has not been taken notice of by Mr. Nicholson. As in *Favosites* the general mode of gemmation is the intermural one. This can be well observed in our figure 1*c* on Pl. XCIX, where on the upper end a new individual is seen taking its origin. This increases very rapidly in size, causing the adjoining corallites to deviate from their original direction.

This identity of the mode of gemmation in *Michelinia* and *Favosites* is one proof more that the two genera are very nearly related, though this has not been admitted by Lindström, Zittel, and others. The reasons for which Lindström places the genus *Michelinia* in the *Cystiphyllidæ* are, the cystoid condition of the tabulæ, the existence of septa in the corallites, and of root-like appendages on the epitheca, and the different morphological interpretation that must be given to the mural pores in the two genera.

As regards the last of these characters we must confess that on thin sections we could not find any difference between the mural pores of *Favosites* and *Michelinia*, either in the figures given by Nicholson (of *Pleurodictyum*) or in preparations we made ourselves. The pores show no regularity whatever in their arrangement, and do not take any heed of the septal furrows which stretch down the walls of the corallites. They pierce these walls directly, and in many of our preparations of silicified specimens a hair can easily be passed through them. They are not all absolutely of the same size; some are larger, some smaller. They are often more clustered together at the base of young individuals which have just taken their origin by gemmation, and thus still communicate freely with the parent individuals.

If thus the mural pores do not seem to warrant a wide separation of *Michelinia* and *Favosites*, the other characters alluded to by Mr. Lindström are still less adapted to make such a separation acceptable. The septa are never developed, but appear as very shallow elevations, separated from each other by barely perceptible furrows, stretching down the internal sides of the walls of the corallites. Since the investigations of Mr. Nicholson however it is known that in certain forms of undoubted *Favositidæ*, as in *Nyctopora*, the septa are at least as well developed, and thus this rudimentary development of septa in *Michelinia*, which is, moreover, often entirely absent in some forms of this genus, cannot be considered as forming a fundamental difference between it and *Favosites*.

As to the cystoid condition of the tabulæ, it must be confessed that such a thing has never been observed in *Favosites* proper; on the other hand, in *Columnopora* a form has been described as truly transitional between *Michelinia* and *Favosites*. In this form the tabulæ are mostly convex, or even partly cystoid, the walls of the single corallites are still more frequently pierced by mural pores than in *Michelinia*, and there are traces of septa developed on the inside of the tubes of the corallites. Thus it can hardly be doubted that *Columnopora* is about equally nearly related to *Michelinia* and to *Favosites*, and the existence of such a transitional form goes far to elucidate the relation of those two genera.

As a last differental character between *Favosites* and *Michelinia* the existence of an epitheca provided with root-like appendages is quoted by Lindström. That in *Favosites* also an epitheca is sometimes developed had been already observed by Quenstedt (Petref. Deutschl., Vol. VI, p. 5). The root-like appendages, however, even in the genus *Michelinia*, only occur in that group of forms of which *Michelinia favosa*, Gdf., is the prototype. In all the other groups these appendages are absent.

Moreover, even if the points of discrepancy are not of such a nature as to warrant a fundamental distinction of *Michelinia* and *Favosites*, there are points of similarity which cannot be overlooked. One of these is the mode of gemmation, which is absolutely identical in *Favosites* and *Michelinia*. On the surface of the corallum the new individuals appear as small, three-, four-, or five-sided calices at the points where three old corallites come together. That the gemmation is truly an intermural one, and that it cannot be stated from which of the old corallites the new one has taken its origin appears beyond doubt from the section represented in fig. 1*c*. Pl. XCIX, where the primordial wall that separates the old corallites is distinctly split into two at the point where a new one takes its origin.

After all that has been said there cannot, it seems to us, remain much doubt that *Michelinia* must be placed in the family *Favositidæ*.

Very nearly related with *Michelinia* is *Pleurodictyum*, which thus cannot be placed, as Zittel advocates, near *Porites* or *Protaræa*. *Pleurodictyum*, if it is at all different from *Michelinia*, deviates from that genus chiefly only by the less frequency of tabulæ in the single corallites.

Just the contrary is the case with *Chonostegites*, E. & H., which has been considered as a synonym of *Michelinia* by Zittel and others. The characters of the genus have been well set forth by Nicholson; one character has not, however, been sufficiently brought forward by him, though it is very clearly represented in his drawings, and also mentioned casually in the description; this is, the "stolonal gemmation,"—as it has been called by Koch in his very important paper on the modes of propagation occurring in corals—, which is very distinctly developed in this genus. This "stolonal gemmation" is characteristic of the *Syringoporidæ* and of *Tubipora*, whilst it generally does not occur in the *Zoantharia*, and thus the genus may perhaps have to be altogether removed from that class and placed in the

Alcyonaria. If then we allow *Chonostegites* to remain in the vicinity of *Michelinia*, it is only provisionally, and on account of the perforation of the walls of the single corallites, which occurs rather frequently in this genus.

The genus *Michelinia* has, up to the present, been observed to occur chiefly in the carboniferous formation; in devonian strata also species of the genus have been found. That the genus occurs again in permian beds has been proved by the detection of specimens by Abich in the permian beds on the Araxes.

In the Salt-range the genus is not at all rare, and occurs most commonly in the middle division of the Productus-limestone, which is made up in a great part of coral reefs; also in the upper division specimens of the genus are not very rare. In the lower division, however, it has not yet been found up to the present.

There are altogether four species of the genus contained in the Salt-range collection. Two of them, ***Mich. abichi***, W. & W., and ***Mich. placenta***, W. & W., occur in the upper division of the Productus-limestone, whilst the third and fourth, ***Mich. indica***, W. &. W., and ***Mich. glomerata***, McCoy, are restricted to the middle division.

1. MICHELINIA ABICHI, Waagen and Wentzel n. sp.

1878. *Michelinia tenuisepta*, (Phill.) Abich: Bergkalkfauna aus der Araxesenge bei Djoulfa, p. 91, pl. 11. fig. 11 (*non* Phillips).
1879. *Michelinia sp. indet.*, Möller: Neu. Jahrb. für Min., 1879, pp. 238-239.
? 1883. *Michelinia sp.*, Kayser: Fauna von Lo-Ping; Richthofen's China, vol. IV, p. 195, pl. XXIX, fig. 15.

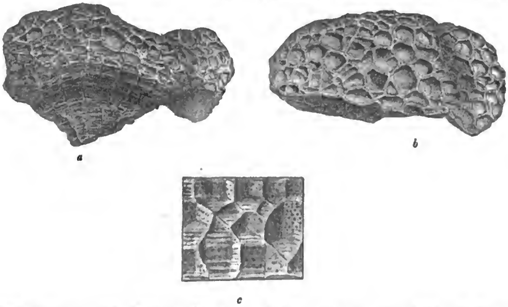

Fig. 26, MICHELINIA ABICHI, Waagen and Wentzel n. sp. Silicified specimen of an entire corallum from the upper Productus-limestone of Kafirkot North: *a*, lateral view; *b*, top-view, both natural size; *c*, some of the calices broken and exposing their lateral faces, enlarged.

Corallum irregularly reversed conical in shape, with an infundibuliform base, which is attached by the median prominence to foreign bodies and otherwise covered by a not very thick concentrically plicated epitheca. Up to the present, no large specimens of this species have been detected, and it is probable that it never much exceeded the size of the figured specimen. Corallites spreading from the place of attachment, ascending at the same time steeply. Their form is irregularly polygonal. The marginal ones are covered by the epitheca in such a manner that their longitudinal extension can be distinguished through it. All the corallites are in close contact, their walls rather thin and not perfectly combined together but showing distinctly in the middle the primary mural plate. Calices very irregularly polygonal in outline, rather small, never larger than 5mm. in diameter, often very much smaller, shallow. Septa indicated by a close but rather indistinct vertical striation of the interior side of the walls. Mural pores not very large, numerous, irregularly arranged. Tabulæ not very numerous, about two to three within the space of 5mm., cystoid, not very strongly vaulted, irregular, often uniting with one another, or with smaller cysts attached parasitically on the margins of the larger ones.

Locality and geological position.—There is only one specimen of this species preserved in the Salt-range collection. This was collected by Mr. Wynne in the trans-Indus continuation of the Salt-range at Kafirkot North, in the higher divisions of the Productus-limestone.

Remarks.—We identify this fossil from the Salt-range with the one that has been described by Abich under the name of ***Michelinia tenuisepta***, Phill., from the upper palæozoic (permian) beds of Djoulfa on the Araxes. It cannot be subject of the slightest doubt that this form is very nearly related to the true ***Mich. tenuisepta***, and there are perhaps many palæontologists who would not advocate the distinction of the Armenian and Indian fossils from Phillips's species. Already however, Möller has drawn attention to the circumstance that in Abich's specimen the calices are considerably smaller than in the typical mountain-limestone species. As the same character is repeated in the Indian specimen, which is of similar geological age as the Armenian one, it seems now probable that a permian form exists which is on the whole very similar to ***Mich. tenuisepta***, Phill., but which can be distinguished by altogether smaller calices. To this form we have given the name of ***Mich. abichi.***

A fossil which seems to be very similar to this ***Mich. abichi***, but which has only been found up to the present in a very bad state of preservation, is the one figured by Kayser from the upper coal-measure beds of Lo-Ping in China. The size of the calices is absolutely the same, and thus it might very easily be the case that we have to deal here with the same species. The question can, however, not be decided before better materials from China are available. If the identity should prove to exist in reality, then the species would have a rather wide geological range, from upper carboniferous to permian.

On the whole it is highly probable that ***Mich. tenuisepta*** is the direct ancestor of ***Mich. abichi***, and that thus both belong to one and the same developmental series.

2. Michelinia placenta, Waagen and Wentzel n. sp.

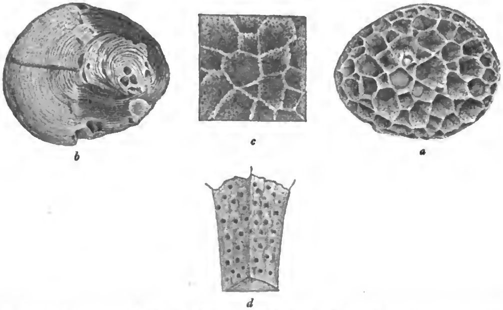

Fig. 27, Michelinia placenta, Waagen and Wentzel n. sp. Silicified specimen from the Cephalopoda bed of the upper Productus-limestone of Jabi:—*a*, top-view; *b*, basal-view, both natural size; *c*, some of the corallites enlarged; *d*, walls of one of the corallites strongly enlarged.

Corallum forming flatly lenticular or somewhat conical masses, with a perfectly flat base and slightly elevated corallites. The base is free, fixed only by a small point to foreign bodies and covered with a very thick rugose epitheca. The whole corallum is of rather moderate size. Corallites short, springing under obtuse angles from the flat base, essentially polygonal, and being for their whole extent in close contact together. Their walls extremely thin and brittle, as thin as paper. Calices distinctly polygonal, deep, very irregular in shape and unequal in size, but never larger than 6mm. in diameter, augmenting very distinctly by intermural gemmation. Septa indicated by a rather indistinct vertical striation of the walls of the corallites, but their number cannot be counted. Mural pores very numerous, not very large and quite irregularly disposed. Tabulæ not very numerous, not strongly inflated, but rather flat, mostly complete, sometimes forming small marginal cysts, not filling the entire room of the corallites.

The specimens at our disposal do not exceed a diameter of 40mm. and do not attain a greater height than 15-20mm.

Locality and geological position.—There are altogether two specimens of this species preserved in the Salt-range collection, which were both found in the Cephalopoda-bed of the upper Productus-limestone of Jabi.

Remarks.—With regard to some characters the present species seems to be again most nearly related to *Mich. tenuisepta*, Phill., with which species it chiefly agrees in the size of the calices, and the vertical striation of the walls of the corallites. It is, however, distinct from Phillips's species by its flat base and the therefore not reversedly conical shape. By these characters the species rather closely approaches *Mich. favosa*, Gdf., which is, however, distinct by the root-like processes which spring from its base.

Of other species, chiefly *Mich. abichi*, described above, must be compared; the distinction of the present species is, however, not difficult; the flat base, the quite different mode of growth, and the larger calices distinguish this form readily from *Mich. abichi*.

3. MICHELINIA INDICA, Waagen and Wentzel, n. sp., Pl. XCIX, fig. 1.

A corallum forming irregular tuberous masses of rather large size, which generally spring from a small, reversedly conical base, covered by a thick epitheca; the basal part is, however, mostly obliterated. Corallites tolerably long, polygonal, indistinctly radiating from an imaginary point; their walls are in close contact throughout and rather thick. Calices not deep, polygonal, four-, five-, or six-sided; on an average 6-8mm. in diameter, rarely somewhat larger. Septa almost entirely absent, and even the vertical striation of the walls of the corallites, by which the septa are represented in most species of *Michelinia*, are barely observable. Mural pores very numerous, rather small, and quite irregularly arranged. Tabulæ very numerous, very strongly inflated, forming highly vaulted cysts, which are very conspicuous; they are mostly complete, but sometimes a number of smaller cysts surround a larger median one. The augmentation of the corallites by intermural gemmation is very distinct. The species attains rather large dimensions. Our largest specimen is 130mm. in diameter.

Locality and geological position.—The present species seems to be restricted to the middle division of the Productus-limestone, where it takes part in the formation of the large coral reefs which are to be observed at certain localities in these beds. It has been found in this position at Virgal in the coral-limestone (1 specimen); east of Katwáhi in the same beds (1 specimen); and in the section at Khura in the top-beds of the middle division.

Remarks.—The form which seems to be most nearly related to *Mich. indica* is *Mich. glomerata*, M'Coy, from the mountain-limestone of Europe. The general appearance of both species is absolutely identical, but on a closer examination one finds that the Indian coral has larger calices, 6-8mm. in diameter, whilst they are only 5 to 6mm. in *Mich. glomerata;* the tabulæ also are much more numerous and much more irregular, so that it very probably forms a different species.

Mich. tenuisepta and the two species described on the foregoing pages are also rather nearly related to our *Mich. indica*, but from all these the latter is distinguished by its entirely different mode of growth, which makes it resemble *Mich. glomerata*.

There can be but little doubt that ***Mich. glomerata*** is the direct ancestor of ***Mich. indica,*** but it appears difficult to adduce undoubtable proofs for such a supposition.

4. MICHELINIA cf. GLOMERATA, M'Coy, Pl. CXVI, fig. 1.

1855. *Michelinia glomerata*, M'Coy: Brit. palæoz. Foss., p. 80., pl. IIIB, fig. 14.

There is a very large coral in the Salt-range collection that may perhaps be directly united with ***Mich. glomerata,*** M'Coy. The general form of the corallum is irregular, forming large flatly tuberous masses of 170 to 200mm. diameter. Corallites not very long, radiating from an imaginary point. Calices polygonal, of rather unequal sizes, but never larger than 5 to 6mm., tolerably deep; the walls not very thin, and without vertical striation in the specimen at our disposal. Mural pores not very conspicuous. Tabulæ rather straight, very numerous, four to six within the distance of 5mm., sometimes with little vesicles along their margins. Intermural gemmation very frequent and distinct.

Locality and geological position.—The only specimen of this species in the Salt-range collection was found by Mr. Wynne in the middle division of the Productus-limestone at Morah. The specimen is calcareous and forms a very large coral, although a large part of it has evidently been broken off. Its longitudinal diameter is 170mm., its breadth 140mm., and its height 90mm.

Remarks.—The present form agrees so very nearly with ***Mich. glomerata*** of M'Coy, that we barely think it advisable to separate it entirely from M'Coy's species. Yet there are some differences, which must not be overlooked. These consist in the tabulæ being nearly straight and considerably more numerous, characters which may no doubt have partly depended upon the circumstances under which the animals lived, but which yet constitute differences of some importance. Thus we have preferred to introduce the present form under the designation of ***Mich. cf. glomerata,*** M'Coy.

From the species previously described in this work, chiefly from ***Mich. indica,*** W. & W., it differs by its considerably smaller calices.

Family: *MONTICULIPORIDÆ.*

The family which has given us the greatest trouble in working out its affinities and its internal structure is that of the ***Monticuliporidæ,*** not only because there had to be taken into consideration two opposite opinions of long standing, one, supported by Lindström and Rominger, regarding these fossils as ***Bryozoa,*** and another, supported strongly by Nicholson, taking them to be corals; but also, because the family as circumscribed by Nicholson could not be retained as made to include forms of ***Alcyonaria*** as well as those belonging to the ***Hexacoralla.***

The first point is therefore to show the affinity of the ***Monticuliporidæ*** to the corals, in opposition to the view which considers them as ***Bryozoa.*** In our endeavours to decide this question great difficulties were encountered on account of the fact that no decisive characters have so far been made out, by which the stony abodes of certain corals and those of the *Bryozoa cyclostomata* could be distinguished. Both consist of minute cells, more or less tubular, often with horizontal partitions or tabulæ; and even organs comparable externally to radial septa are not entirely absent in some *Bryozoa;* from all which it appears that in fossil forms neither the general habitus of the colonies nor the internal characters of the single cells can be made use of for the distinction of the *Monticuliporidæ* and the *Bryozoa.* Yet after careful studies we detected certain distinctive characters in the modes of propagation which are so radically different as to affect the shape and structure of the colonies; the structure of the walls of the cells is also different in the *Monticuliporidæ* and in the *Bryozoa.*

In all these considerations, however, we must exclude the genus *Heteropora,* Blv. In its structure, it cannot be denied, this genus exhibits a certain affinity to the *Monticuliporidæ,* but there are also so many discrepancies that its real relations must probably be looked for in other quarters. We were ourselves not in a position to make observations on recent species of the genus, but the descriptions given by Nicholson are so excellent that barely any new facts can be brought to light. As far as can be judged from Nicholson's drawings, the propagation in *Heteropora* is exactly like that prevailing in *Monticulipora* or *Favosites,* whereby a central and a peripheral zone can be distinguished in the colonies of *Heteropora* as in *Favosites.* Mural pores are very numerous, and though Mr. Nicholson thinks them to be different from the mural pores of the *Favositidæ* by having proper walls, yet we cannot but record the fact, that we have repeatedly observed distinct walls surrounding the mural pores in true *Favositidæ,* and that it appears to be only a matter of exceptional preservation whether such walls can be distinguished or not. In the recent form of *Heteropora* studied by Mr. Nicholson, tabulæ occur only sparingly in the cells properly speaking, and are entirely absent in the interstitial tubes, whilst in fossil forms tabulæ appear in numbers in all the tubes of which the colony is composed; as an instance of this the figure of *Heterop. pustulosa,* Mich., in Zittel's Handbook Vol. I p. 611, may be compared. Lastly there occur in *Heteropora* numerous septal spines which are comparable to similar organs that very commonly occur among the *Favositidæ.* After all these facts we perfectly concur with Mr. Nicholson in his final opinion "that the pore-canals, septal spines and tabulæ, which are now known to exist in some species of *Heteropora,* are, at any rate, as reconcilable with its reference to the *Cœlenterata* as to the *Polyzoa.*" We may perhaps add that the modes of propagation observable in *Heteropora* are more in favour of placing the genus with the *Cœlenterata* than with any other group of animals. So long, however, as the animals inhabiting the colonies of *Heteropora* are not known, it is more or less useless to speculate on the systematic position of these objects. It may suffice to have proved that the systematic position of *Heteropora* is by no means certain, and as *Heteropora* is precisely the only connecting link between the *Bryozoa* and the *Monticuliporidæ* such a demonstration goes already far towards elucidating the systematic position of the latter. If *Heteropora*, from a careful study of its animals, should ever be proved to be a *Bryozoon*, then also the *Favositidæ* would have to be removed to the *Bryozoa*, and Dollfuss's views in the matter would be perfectly justified. The relation of *Favosites* to *Alveopora*, *Favositipora*, and the like would, however, then remain an unsolved riddle. As the matter now stands, we may be perfectly justified if we exclude the genus *Heteropora* altogether.

If we turn now to the modes of propagation occurring in different groups of animals, we find, that in the *Bryozoa* there is only one such mode observable, and that is gemmation. In the corals, on the contrary, two such modes have been long since made known—*fissiparity* and *gemmation*. Whilst however in the *Bryozoa* gemmation takes place only in a single manner, by protruding one of the walls of the mother-cell and afterwards partitioning off the protruded part, there are many different ways in which gemmation has been observed to occur in corals. With regard to the gemmation of the *Bryozoa* very excellent observations have been published by Barrois (Recherches sur l'embryologie des Bryosoaires. Lille. 1877), Nitsche, Claparède, etc: ; the mode of gemmation in the corals on the other hand has been studied in detail by Koch, whose chief work on the subject has been published in the Palæontographica (III Ser., Vol. V).

The difference between the animals inhabiting the colonies of *Bryozoa* and those that build up the colonies of corals are extremely striking in many respects, and must find their expression also in the mode in which the colonies are built up. The animals of the *Bryozoa* are in the first place much less long-lived than those of the corals, as they show, for by far the longest part of their existence, a so-called latent vitality. Each animal of a colony of Bryozoans produces one or two gems, only exceptionally more, all nearly simultaneously, and mostly whilst it is yet in a rather juvenile state, after which it stops its functions in this direction. The animal of a colony of corals never stops producing gems but develops them at all times of its life and at different levels. This difference alone is the cause of a quite different growth of the colonies of the two classes of animals. Whilst in the *Bryozoa* gems are produced only in the peripheral parts of the colony, augmentation only occurs at the margin of the whole colony, as for instance in *Brenicea*, or in arborescent forms only at the apex of the branches, as in *Entalophora*, in the corals gems are produced all over the colony, in great numbers if the animals are well off, well fed, etc., and in smaller numbers if the contrary is the case. This circumstance then accounts for the very striking contrast existing in the outward aspect of corals and *Bryozoa*. Whilst in the corals everywhere small calices are intermingled with larger ones, in the true *Bryozoa* (we do not speak here of *Heteropora*) the smaller cells are to be found only in the peripheral parts of the colony, the cells elsewhere being all of the same size. The internal structure as well becomes very different, as is chiefly apparent in the arborescent forms, a mode of growth which is also most generally affected by the *Monticuliporidæ*. If we make a longitudinal section through a branch of an arborescent colony of a *Bryozoon* we find that all the cells take their origin in a most regular manner at the imaginary axis, slowly ascending and bending sideways to reach the surface of the branch. There is no splitting of these cells; the gemmation is restricted to the vicinity of the imaginary axis, and thus the distinction of a central and a peripheral part of the branch, as can always be made in the branches of *Monticuliporidæ*, is impossible. In forms like *Cellepora* in which the colonies form a mere agglomeration of accumulated cells, the mother-cells, from which the new ones have taken their origin, can always very distinctly be made out; and it must not be forgotten that for the propagation of vitality there must remain free communication between the young feeding animals and the old ones, for the passage of the nutritive fluid, so that more or less large pores must remain open in the walls of all the single cells by which the animals communicate with each other.

Having thus in a general way indicated the mode of propagation prevailing in the *Bryozoa* on the one hand, and in the corals on the other, we may now turn more in detail to that of the *Bryozoa* and of the *Monticuliporidæ*.

After Mr. Smith's discovery of a kind of dimorphism or metamorphosis occurring in the colonies of *Bryozoa*, whereby such a colony in the young state would seem to belong to another genus from that presented in its more advanced state of growth, the question of the propagation or gemmation in the *Bryozoa* was placed in a new light. The endeavour on the part of Mr. Barrois to treat this subject more in detail in his very important work on the Embryology of the Bryozoa must be thankfully acknowledged. The point which is of the utmost value to us is that Mr. Barrois demonstrated beyond any doubt that in the *Bryozoa* the mode of gemmation in all cases remains the same. He says in this respect (p. 77 of his work): "J'ai toujours observé comme on peut le voir dans le bourgeonnement de la loge primitive, que les nouvelles loges se formaient par simple renflement, suivie du cloisonnement, de la loge précédente; la chose m'a paru se passer de même pour tous les bourgeonnements successifs aussi bien chez les *Phalangelles* que chez les *Crisies* et tous les autres cas que j'ai pu observer." This is how propagation takes place in the *Cyclostomata*, that group of *Bryozoa* which can alone be considered as perhaps allied to the *Monticuliporidæ*.

Somewhat different is the mode of propagation in the *Chilostomata*. With regard to this group very exact observations have been made on *Flustra membranacea*, Linn., by Dr. Nitsche. In the beginning, so long as the colony is still very young, the propagation resembles to a certain extent that of the *Cyclostomata*, but in old colonies, the separate animals are prolonged in creeping radial tubes, which sometimes bifurcate, and in which, at the proximal end, parts are constantly chambered off as soon as they have reached the normal length of one of the animals. These chambers are the gems in which the animals are slowly developed. In the meantime the tube constantly augments in length at the distal end. This mode of gemmation is the least important for us, as it has been observed up to the present in the *Chilostomata* only; it appears, however, more or less as a modification of that occurring in the *Cyclostomata*. Another mode of gemmation, almost entirely in accordance with that occurring in *Cyclostomata*, has been described by Claparède in several arborescent forms of *Chilostomata*. From all that we can gather with regard to the gemmation of recent *Bryozoa* it appears that, besides having the gemmation restricted to a very short period in the single animal's life, the production of gems is also restricted to one side of the animal only. It is always on the side opposite the aperture of the cell. This can very easily be made out in the *Chilostomata*, where the aperture is always more or less lateral; but also in the *Cyclostomata*, where the aperture is terminal, the apex always bends to one side, opposite to the side on which gems are produced. We will call the gem-producing side the dorsal one. In creeping colonies this dorsal side is turned downwards, in arborescent forms it is turned inwards, towards the axis of the stem. If thus a creeping colony changes into an arborescent one, the animals must turn round to a certain extent, to bring their dorsal sides into a fitting position; but that is all the change that takes place in such a case.

In the corals on the contrary, gemmation takes place indiscriminately on all sides of the animal, and therefore no linear descent of the respective animals is observable.

In the *Monticuliporidæ* propagation occurs in a way which deviates very far from the modes described in the *Bryozoa*. As in corals two essentially different modes of propagation are observable: gemmation and fissiparity. The first of these is the more common one and therefore we shall consider it first in the *Monticuliporidæ*. If we turn to Prof. Koch's extremely important paper on the propagation of corals, we find that he does not retain the old opinion as to the essential difference between fissiparity and gemmation, and from a biological point of view such a distinction may indeed not be entirely justifiable, but from a practical point of view it appears to us as of great importance. Mr. Koch distinguishes six different modes of gemmation, two of which would, according to former views, correspond to fissiparity, whilst the other four would represent gemmation in the more restricted sense. We have now observed that the modes of gemmation in the more restricted sense are characteristic of single groups or even large divisions of the *Anthozoa*, whilst fissiparity is not restricted to a single group or class, but occurs off and on in all forms along with one or the other form of gemmation, though again on the other hand, fissiparity becomes the rule in certain large groups of corals nearly to the exclusion of gemmation. From these considerations it seems desirable to retain the distinction between fissiparity and gemmation, and thus we shall treat of each separately.

The four modes of gemmation are classed by Koch in the following manner:—

A—Internal gemmation:—

a, Tabular gemmation: the young corallites are produced by means of singularly transformed tabulæ.

This mode of gemmation chiefly occurs in the *Rugosa* or *Tetracoralla*.

B—External gemmation :—

- *a*, Intermural gemmation : the young corallites are produced by the splitting of the primary mural plate (or primordial wall) of two or more adjoining corallites.
- *b*, Cœnenchymal gemmation : young corallites are produced by the fusion of several interstitial tubes.
- *c*, Stolonal gemmation : young corallites are produced by the budding of one of the stolones.

The last of these modes of gemmation is entirely restricted to the *Alcyonaria* ; the second seems chiefly so, whilst the first has been observed up to the present in *Favositidæ* and some *Hexacoralla*.

If we regard the *Monticuliporidæ* as a whole, as they have been circumscribed by Nicholson, we find that in the forms thus comprised under the name two of the above distinguished modes of gemmation are observable—the intermural and the cœnenchymal gemmations. According to the occurrence of the two modes of gemmation two different groups of forms can be distinguished within Nicholson's *Monticuliporidæ*, of one of which the genus *Monticulipora*, whilst of the other the genus *Fistulipora*, may be considered as the types. We take the two groups as forming two different families, for the one of which we retain the name of *Monticuliporidæ*, whilst for the other we create the name of *Fistuliporidæ*. The latter family must, however, at the same time be removed to the *Alcyonaria*, a mode of proceeding which will be justified later on.

In the *Monticuliporidæ* in this restricted sense, there exists only one mode of gemmation and this is the intermural one, which is chiefly characterised by the circumstance that the young animal formed by gemmation has no part in common with the mother animal, so that it is impossible to say from which of the surrounding animals the new one took its origin. It looks as if the new animal were only filling up a void space between several old animals.

The gemmation can very easily be made out on tangential sections of the fossils belonging to the family. It needs only a glance at our Pl. CX, figs. 1*c* and 3*c*, or Pl. CXIV, fig. 2*c*, to become convinced of this. Generally gems are developed where three or more corallites come into contact, but also at other places they are sometimes to be found.

Gemmation very generally commences with a thickening of the primary mural plate or primordial wall. These thickenings can easily be recognised in this connection when they occur where several corallites meet; but when they occur at intervals in the extension of the primary mural plates, as is not rarely the case, then their interpretation has caused much difficulty. These thickenings have then been called "Wandstränge" (mural strings) by Dybowsky, and have partly been considered as the so-called spiniform corallites by Nicholson. Our figures Pl. CX, figs. 1*c* and 3*c*, are chiefly instructive in this respect; it may be useful at the same time to compare

Pl. CXIII, figs. 1*e*, 1*f*, 3 and 4. These thickenings are of very varying extent. Sometimes they stretch over long distances before the formation of a new corallite actually takes place, sometimes the thickening occurs only just before it makes its appearance. Even in one and the same corallum differences in this respect can be observed at different levels within the colonies.

After this thickening has been completed then the primary mural plate of the new individual thus developed begins to be formed. In the middle of the originally dark thickening, light coloured wall-substance appears, surrounded by dark lines, indicating the primordial wall of the new individual. In this state no hollow for the reception of the animal as yet exists. This state of development is not often to be observed, as it lasts only for a short interval. Nevertheless it is occasionally exhibited in our figures: for instance in Pl. CX, fig. 3*c*, such a gem can be observed, of a triangular shape, bearing at its corners already again thickenings, the commencement of new gems. Also in Pl. CXIV, fig. 2*c*, this state of development can be observed.

The third and last state of development is reached when the light-coloured wall-substance in the middle of the gem becomes perforated, thus forming the hollow for the reception of the animal. This state of development can very easily be seen in every tangential section, but caution is needed not to mistake it for that produced by fissiparity, which is not very different in appearance. With some practice, however, it will not be difficult to distinguish between the two modes of propagation. Very frequently the two occur together in one and the same section.

It is rather rare that all the three stages in the development of the genus can be distinguished, as in very many cases the primordial wall has either been obliterated or otherwise altered by the process of fossilisation. Often mineral matter has been deposited on it, and then often the primordial walls appear as if resolved into a string of beads, and the thickenings which afterwards give rise to the formation of gems cannot well be made out (compare in this respect Pl. CX, fig. 1*c*, Pl. CIX, fig. 2*a*, &c.). In most cases, however, the first and the last stage of development can be well distinguished. The difficulty of observation of the intermediate state probably caused Mr. Nicholson to mistake such half-developed gems as singularly transformed individuals, for which he introduced the name of spiniform corallites.

The intermural gemmation cannot be so clearly discerned in longitudinal sections. The cause of this may be found in the circumstance that in such sections more than two individuals can never be seen in close contact. Nevertheless in such sections also the process of gemmation can be well made out, and it needs only a look at Pl. CX, fig. 1*d*, to become convinced of this. The primary mural plate, here indicated by a dark line, ascends, and suddenly divides in two, enclosing in the acute angle thus formed light coloured wall-substance. Higher up the hollow is formed in which the new animal resided.

A few schematic figures will show the process of gemmation more clearly than any description can; to this end we present here some such figures:—

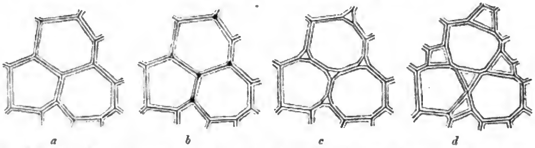

Fig. 28. Schematic figures of the intermural gemmation of a *Monticuliporid* as seen in tangential sections: *a*, three corallites without gems; *b*, the same with the commencement of gemmation, showing thickenings of the primordial walls where three corallites meet; *c*, the primordial walls of the gems are already formed, but no hollows for the reception of the animals are as yet present; *d*, the gems fully developed, but as yet of smaller size than the mother-animals.

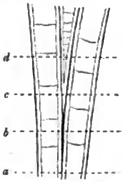

Fig. 29. Schematic figure showing the intermural gemmation of a *Monticuliporid* as seen in a longitudinal section: the dotted lines *a*, *b*, *c*, *d* corresponding to the tangential sections represented in fig. 28, with the sole difference that in the present figure only two corallites with only one gem between them is represented.

This gemmation, as now described in detail, is certainly very far different from the mode of gemmation occurring in *Bryozoa*, as described above. The most radical difference always consists in the circumstance that in the *Bryozoa* the fully developed animals do not produce gems, but only the quite young ones, which are themselves still more or less in the state of buds. After this the next important difference is, that in *Bryozoa* the mother-animal, from which the new one took its origin, can always be made out, whilst this is not the case in the *Monticuliporæ*.

On the other hand the gemmation which we have just described in detail in the *Monticuliporidæ*, is absolutely identical with that occurring in the *Favositidæ*, and Koch's figures of the gemmation of *Favosites gothlandica*, Gdf., might almost as well be taken from specimens of *Monticulipora*, the only difference being, that the thickenings of the primary mural plate inaugurating the formation of gems is more frequent in the *Monticuliporidæ* than in *Favosites*, whereby results the fact that the corallites at the surface of the colonies are of more unequal size in the *Monticuliporidæ* than in the *Favositidæ*.

Another mode of propagation is, as has been stated above, that which is brought about by fissiparity. Fissiparity, however, is a mode of propagation which points to such a low organisation of the animals in which it occurs, that, when we are able to prove its occurrence in the *Monticuliporidæ*, it appears absolutely impossible to unite them with the *Bryozoa*.

As a fact, fissiparity is not at all of rare occurrence in the *Monticuliporidæ*, and there are numbers of figures in the works of Nicholson and Dybowsky which show very distinctly this mode of propagation. It needs only a reference to Pl. I, figs. 1—3 of Dybowsky, or Pl. I, figs. 4*c* 4*d*, Pl. III, figs. 3*e* 3*f*, Pl. VI, figs. 1*f* 1*g*, and to the woodcuts on page 171, fig. 32 *C*, or page 173, fig. 33 *B*, of Nicholson's work on the *Monticuliporidæ* to confirm this assertion. Fissiparity can very easily be distinguished from gemmation by the circumstance that the internal space of the new animal forms part of the internal space of the mother-animal. It can more easily be distinguished in longitudinal than in tangential sections. In longitudinal sections this mode of propagation can easily be recognised, inasmuch as in this case within the space of one of the corallites, which is well characterised by the two longitudinal walls stretching along, between which the tabulæ are spread out—a new longitudinal wall suddenly appears, dividing the internal room of the old corallite into two, and thus giving rise to two new corallites. Generally such a new longitudinal wall begins at one of the tabulæ, and to understand this, it may be well to accept the opinion, that only that part of the corallite above the last tabula was occupied by the living animal, whilst all below was dead.

In tangential sections fissiparity can less easily be distinguished. One can, however, often observe one corner of a polygonal corallite partitioned off by an oblique wall, whereby a new animal of more or less triangular shape is formed, which slowly increases in size and assumes by degrees a polygonal outline. This view, in combination with the one represented by the longitudinal section gives a fair idea of the manner in which fissiparity takes place; the animal is literally split in two by a wall, which stretches from one side of its body-cavity to the other. The radical difference of this mode of propagation from the intermural gemmation described above is obvious.

Also in this case schematic figures will perhaps give a more clear idea of the process than description can do; we therefore give some figures representing fissiparity.

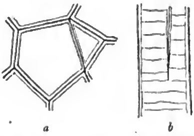

Fig. 30. Schematic figures representing fissiparity as occurring in the *Monticuliporids*: *a*, transverse section of a corallite bearing at its side a young animal produced by fissiparity; *b*, longitudinal section of a corallite showing the splitting into two of the mother-animal.

It cannot be asserted that something like fissiparity has never been observed in *Bryozoa*, whilst it is of very general occurrence in corals. Formerly the opinion was entertained that *Chætetes* increased solely by fissiparity, whilst in *Monticulipora* gemmation alone should occur. As to *Chætetes* we cannot express any opinion, as we had no materials for observation, but with regard to *Monticulipora* already Nicholson expresses strong doubts as to gemmation being the sole mode of increase. The difficulty was always that one was not inclined to admit the two modes of propagation as occurring in one and the same form; but in the course of our investigations we so often found that fissiparity existed together with gemmation in one and the same colony of corals that we must consider fissiparity as a perfectly independent mode of propagation, which occurs off and on throughout the whole class, whilst the special mode of gemmation is characteristic of single groups.

If thus the mode of increase of the colonies of the *Monticuliporæ* seems not to be in favour of the supposition of these organisms being *Bryozoa*, there are yet other points which also oppose such a supposition. One of these is the structure of the walls in the *Monticuliporæ* and in the *Bryozoa*. There are many forms of *Bryozoa* which deposit carbonate of lime in the ectocyst of their body more or less abundantly. This deposition takes place in the median layer of the ectocyst only, whilst the outer and inner layers remain of a horny nature, which probably is the cause that in thin sections the calcareous walls of the single individuals appear separated from each other by dark lines. If we now consider more in detail the structure of the calcareous substance of which the walls of the cells are built, we find that it is composed of very thin fibres placed vertically to the surfaces of the wall, so that in sections cutting the single cells transversely, a concentric arrangement of the fibres can never be observed. These fibres leave interstices between them at intervals producing numerous capillary tubes, by which the walls of the *Bryozoa* seem always to be pierced in great numbers, if otherwise sufficiently well preserved. Every work on recent or fossil *Bryozoa* shows this. Either these capillary tubes occur all over the surface of the walls or they are restricted to certain places, as in the *Fenestellidæ*, to the so-called basal plate, or in the *Petaloporidæ*, to the thickened wall-substance between the single pores.

An exception to the rule seems to be made by *Heterodictya*, Nich., where the walls seem to be built of parallel calcareous plates, according to Mr. Nicholson's drawings.

Of all this there is not a trace in the *Monticuliporidæ*. The chief element of the walls of the single individuals is here the primary mural plate, or primordial wall as it is called by Nicholson. This primordial wall appears in most cases as a dark line hemmed in on both sides by light coloured masses of sclerenchyma, which latter in itself again is made up of oblique, symmetrically arranged fibres. In the axial parts of the colony, the walls that separate the single individuals consist generally solely of this primary mural plate. Nicholson thinks that this primordial wall must be made up of two thin laminæ, each of which would belong to a different individual; but though we took great trouble, had excellently preserved preparations at our disposal, and could thus employ very high magnifying powers, we were never able actually to distinguish such a duplex structure of the primordial wall, and we are forced to the conclusion that such does not exist, and that in the axial parts of the colonies the primordial wall is in common to two adjoining individuals.

The preservation of this primordial wall is extremely uncertain, and this great variability in the preservation often causes very different aspects even at different places of one and the same preparation. In the normal state, as has been mentioned above, it appears as of a dark compact substance, and forms a dark boundary line between the different individuals. In other cases it is replaced by light coloured calcareous matter or resolved into a series of dark spots, as for instance in ***Orbipora distincta***, Eichw., as figured by Dybowsky, Pl. II, fig. 10. These different modes of preservation must, however, not be mistaken as radically different things.

This primordial wall is hemmed in on both sides, as has been stated above, by secondary thickenings which may appear either at a rather early state of development of the single individuals or only later on, as is chiefly the case in ***Dianulites petropolitanus***, Eichw., and similar forms, where the thickenings appear only quite at the peripheral parts of the colony and never become very thick. These secondary thickenings very easily fall off, and are the cause that natural fractures always take place along the primary mural plate. This latter sticks to one side of the fracture, whilst the secondary thickening on the fractured side of the primordial wall adheres to the other side of the fracture, which causes the appearance as if the primordial wall had split in two. In the axial zone of the colonies the fractures also take place along the primordial walls, but the latter adheres entirely to one side of the fracture, whilst the other side exposes the smooth internal cast of the adjoining individual, which by the extreme thinness of the primordial wall, and the barely perceptible difference which thus exists between the two sides of the fracture, can only with difficulty be recognised as such.

The secondary thickenings are always composed of successive reversed conical layers of sclerenchyma, as has been observed already by Nicholson. In tangential sections the successive layers thus appear as concentric rings surrounding the visceral cavities of the single corallites. But also here again preservation is of the utmost influence on the appearance of preparations, and it is very easy to fall into mistakes on this account. Very often, chiefly in cases where the primary mural plate is not well preserved or has entirely disappeared, these rings, formed by the secondary thickening of the wall, are only partly visible, and then mostly only as a zone surrounding the visceral cavity, and being of very variable thickness in different specimens, can be clearly made out. This zone is then very distinctly limited off, and it seems to us, that in species like ***Monticulipora ramosa***, E. and H., or ***Mont. rugosa***, E. and H., &c., this zone or the outer limit of it has been mistaken by Nicholson to be the primary wall. In all cases where such 'marginal rings' have been figured by Nicholson in the tangential sections, the longitudinal sections of the same species show nothing of such an organ, but they most distinctly exhibit the primordial wall along the *middle line* between two adjoining corallites: an unmistakable indication that the appearance of marginal rings is caused solely by the mode of preservation.

The reversed conical layers of which the secondary thickenings of the walls consist are again themselves composed of little fibres, which extend parallel to the layers.

The difference in the wall-structure of *Monticulipora* and the *Bryozoa* is thus obvious. It results from the mode of growth prevailing in the corals on the one hand and the *Bryozoa* on the other. The *Bryozoon* as an animal of rather high organization is very short-lived; its abode is completed as soon as the gem has attained fullsize; the animal is only for a very short time a feeder, after which it assumes a latent vitality in which its chief function is restricted to the thickening of the walls of its lodge, and thus strengthening the stony parts of the whole colony. The size of the lodge is fixed and cannot be extended beyond the length of the animal. If tabulæ really do occur in such forms, they are not a sign of progressing growth of the zooid; the probable explanation is that in the retrograde metamorphosis to which the zooids are subject, a shrinking of the animal occurs, and in this shrinking process the animal deposits from time to time diaphragms behind its ever contracting body. Just the reverse is the case in the corals.

The animals of a colony of corals undergo constantly a certain process of renovation. The animal deposits large masses of sclerenchyma behind itself and thus slowly ascends within its tube, sometimes chambering off the dead and useless parts of the corallum by diaphragms or tabulæ. The animals are all self-feeding, performing all their vital functions during their whole lifetime, at the same time constantly producing new gems. The structure of the walls is in accordance with these peculiarities. The reversedly conical layers of sclerenchyma by which the wall of the *Monticuliporæ* is built up indicate the ascending movement of the animal within its tube.

The circumstance, that the greater part of the animals of a colony of *Bryozoa* is in a state of latent life, the functions of taking and digesting food being performed only by a few animals at the top of the branches in arborescent colonies, brings with it the other peculiarity, that all the animals of a colony are in intimate connection and communication together. This communication seems to be brought about partly by the capillary tubes mentioned above; for the most part, however, it is effected by large openings in the walls of the lodges, by which a free communication of all the animals of a colony is established. If the *Monticuliporæ* were *Bryozoa* such openings must exist and they must have been observed in some case or other, but nothing of the kind has ever been detected.

From all this it appears highly probable that the *Monticuliporæ* are no *Bryozoa*, and as they show the greatest affinity to the *Favositidæ* it is very probable that they must be considered as corals and placed among the *Hexacoralla*.

In opposition to all this stand Mr. Lindström's observations, which affirm a metamorphosis in the *Monticuliporæ* similar to that which has been observed by

Smith in living *Bryozoa*. Two cases of metamorphosis are treated more in detail, first, that of *Monticulipora ostiolata*, of which he states, that it begins its career as a *Discoporella*, changes next into a *Fistulipora*, then into a *Thecostegites*, to become at last a true *Monticulipora;* second, that of *Monticulipora* (*Dianulites*) *petropolitana*, which is stated to begin as a *Ceramopora*, and even during its growth is off and on again changed into that genus, a case of atavism.

The latter case has been treated of already by Nicholson in his book on the *Monticuliporidæ*, and he adduces many reasons why such a change should be considered as very improbable. To these we may add the circumstance that *Dianulites petropolitanus* shows unmistakably an intermural gemmation, a character which is absolutely prohibitory to a *Bryozoan* nature of the fossil. Dybowsky remarks, that the species here adduced sometimes appears incrustating, and the same can be said of *Ceramopora*. It might thus well be the case that the specimens examined by Mr. Lindström showed the two forms, one incrustating the other.

The first case is, according to our investigations, still far more extraordinary. We must confess that, among the materials at our disposal, we were never able to detect a similar change from one form into the other, though incrustation of very different things, one over the other, are of very general occurrence. There is no doubt that Mr. Lindström was able to state similar superpositions of one form over the other, but whether they also were not incrustations we are not able to decide.

There are many reasons which make it probable, that also in Mr. Lindström's specimens only superposition of different forms was in reality present. That Mr. Lindström has been forced to compare the quite young state of *Monticulipora* to *Discoporella* is not a very surprising fact. *Monticulipora* as well as *Fistulipora*, *Thecostegites*, and a great many *Bryozoa* must in their quite young state show so much similarity to each other that a distinction will in reality be very difficult. Each of these forms is oviparous, and the first lodge developes out of the egg. Though this process is very different in corals and in *Bryozoa*, yet in fossil forms certainly this difference can mostly not be made out. From this first lodge the others take their origin by gemmation, but the colony must attain a certain size before the differences of gemmation as existing in corals and in *Bryozoa* can be made out in fossil forms. Thus the exact determination of quite young specimens will always remain doubtful, and mistakes, taking *Bryozoa* for corals, and corals for *Bryozoa*, will be unavoidable.

In more advanced stages of growth, however, an exact determination can always be made, and then also the observations of Mr. Lindström point rather to incrustation than to metamorphosis. If we take only the mode of gemmation into consideration, we find that *Fistulipora* has a cœnenchymal gemmation, *Thecostegites* a stolonal gemmation, and *Monticulipora* an intermural gemmation. There are now two facts which must here be taken into consideration; first, that in the *Bryozoa* the mode of gemmation is always the same, and shows much less variation than in corals, and that in corals also only one mode of gemmation occurs within one and the same genus or even the same family. According to the mode of gemmation *Thecostegites* and *Fistulipora* belong to the *Alcyonaria*, and *Monticulipora* to the *Hexacoralla;* and it is almost impossible that one should change into the other. On the other hand, it is a fact that *Fistulipora minor*, which is quoted by Lindström as the *Fistulipora*-stage of a *Monticulipora*, is an incrustating species as stated by Mc'Coy, so is *Thecostegites* incrustating, as mentioned by Quenstedt in his Petrefactenkunde Deutschlands, Vol. VI, part 1, p. 121. That *Monticuliporæ* are often incrustating we can state from our own observations. How frequently incrustation occurs in general is shown by our own plates, where Pl. CIX, fig. 3*b*, Pl. CX, fig. 2*b c*, Pl. CXII, figs. 1, 3, & 5, and Pl. CXIV, fig. 2*d* & 3*b* shew such incrustations.

Thus, then, Mr. Lindström's observations cannot change our view that the *Monticuliporæ* are corals.

After having settled, as far as possible, the position of the family, at least as far as its relations to the corals in general are concerned, we can now turn to discuss the structural characters of the *Monticuliporidæ*. The discussion of this is for us comparatively easy, as in the excellent works of Nicholson and Dybowsky, the general features of the structure have been sufficiently treated, so that we are not obliged to repeat here all that has been said in those works. Nevertheless, we must treat some points more in detail, as in these, we regret to say, we are not quite in accordance with the views expressed by Nicholson.

Mr. Nicholson has expressed the opinion that all the *Monticuliporidæ* were dimorphic, and that they thus ought all to be considered as belonging to the *Alcyonaria.* Though there cannot be any doubt as to the fact that certain forms, which were formerly included by Nicholson in the family, and even some of those which he includes in the genus are in reality dimorphic, yet another part, and that the greater number of forms included in *Monticulipora*, are as certainly not dimorphic, and thus radically different from the first. The dimorphic forms are those which show a cœnenchyma intercalated between the corallites proper, composed of numerous interstitial distinctly tabulated tubes, which augment by fissiparity, whilst the large corrallites interspersed between them augment by cœnenchymal gemmation as defined above.

Mr. Nicholson may kindly excuse us when in this case we employ the term "cœnenchyma," to which he so strongly objects with regard to Dybowsky's work; but since such an excellent observer as Mr. Koch has also applied the expression in *Heliolites* and other true *Alcyonaria*, we may be allowed to employ it here for simplicity's sake. This group of forms is chiefly typified by the genus *Fistulipora*, Mc'Coy, and is very nearly related to *Heliolites*. Of the species described in Nicholson's large book on the genus *Monticulipora: Diplotrypa whiteavesii* Nich., *Diplotr. calycula* James, *Prasopora selwynii* Nich., *Prasopora newberryi* Nich., *Pras. grayæ* Nich. and Eth., and *Geronopora cincinnatiensis* James, which all show, according to Nicholson's drawings, a cœnenchymal gemmation, belong also to this group of forms. We shall have occasion in the course of this work to unite all these forms under a proper family which will bear the name of *Fistuliporidæ*.

The forms, however, which have no cœnenchymal gemmation, are not dimorphic, as we shall prove presently. It would be strange if an observer of such excellent qualities as Mr. Nicholson should have overlooked all the facts which speak against a dimorphism, and accordingly we find also in his book on page 50 the following passage: "At the same time, there are forms, otherwise quite resembling the dimorphic species, in which all the corallites of the colony are apparently similar in their internal structure and approximately equal in size, so that we are not able to assert positively that the corallum in *Monticulipora* invariably consisted of two different sets of tubes." The first character which induced Mr. Nicholson to accept the idea of two different sets of corallites in the *Monticuliporidæ* is the existence of differently sized tubes, opening on the surface of the corallum, which is very striking even to the casual observer.

It cannot, however, be denied that this character is decidedly not restricted to the *Monticuliporidæ*. In the *Favositidæ* it is nearly just as striking, and has caused Mr. Moseley to consider even these as belonging to the *Alcyonaria*. In the case of the *Favositidæ* the question seems now settled, after the detection of the near relation that exists between *Favosites* and some *Hexacoralla* of the family *Poritidæ;* and notwithstanding the different sizes of the corallites very often exhibited by *Favosites* and allied genera, these forms are now generally placed among the *Hexacoralla*. Thus also in the *Monticuliporidæ* the existence of differently sized corallites cannot be considered as a character that absolutely requires a systematic position for these forms, placing them in the *Alcyonaria*. It was chiefly Quenstedt, in his Petrefaktenkunde Deutschlands, who remonstrated most decidedly against laying too great a weight on the different sizes of the single corallites, and every observer who has studied *Monticuliporæ* in detail knows that different parts of one and the same colony may be absolutely different with regard to the corallites of which they are composed. Very often the central part of the colony shows corallites not very different in size, whilst in the peripheral parts large and small corallites are mixed together in the most irregular manner. Dybowsky has already made similar observations; he says of *Dianulites fastigiatus* on page 23 of his work: "Whilst in the middle of the colony the polygons corresponding to the transversely cut corallites are tolerably equal in size (Pl. I, fig. 1) the same polygons in a tangential section taken from the periphery of the colony are very unequally sized. Here numerous small polygons are irregularly interspersed between large ones (Pl. I, fig. 2)."

Though already from these considerations it becomes apparent how little systematic value can be put on the variable size of the single corallites, this fact becomes far more evident by the consideration of the mode in which the differently sized corallites originate. It needs only a look at any of Nicholson's, Dybowsky's, or our own drawings to see that the smaller corallites are young ones or gems which have not yet attained their full development, and which have been produced by intermural gemmation. It is true that many of these never will attain the full size of the mother animals, as the corrallum generally stops growth at a certain size, and does not go on growing for ever, but it is only accidental that a certain number of the young individuals produced by gemmation cannot attain their full size, as all gems produced at earlier stages of growth do so, and only those produced just before the corallum has reached its final size, stop short before reaching their full development. As, however, the animals inhabiting the corals never stop producing gems, it is only natural that the gems produced just before the whole colony ceases augmenting in thickness or length appear in very different states of development on the surface of the corallum, some as small pores, but otherwise similar to the mother animals, and some even only as thickenings of the primordial wall,—a state which has been described above as inaugurating gemmation,—and projecting as little spines above the upper termination of that wall. Thus in all stages of growth large pores, small pores, and sometimes also little spines (spiniform corallites) will be observable on the surface of colonies of the *Monticuliporidæ*. There are however yet some observations to be made with regard to the frequency of gemmation. H. v. Heider has published in the Sitzungsberichte of the Academy of Sciences of Vienna (1881, Vol. 84, p. 636) notices regarding the gemmiferation of recent corals, and he remarks that the frequency of production of gems varies to a great extent with the outer circumstances under which a colony exists. If these are favourable and the single animals get plenty of food then gems are produced in endless numbers; but change the outward circumstances, let food become scarce, and so on, then the production of gems is greatly reduced. The same is observable in *Monticuliporidæ*, but here this is not without influence on the outward appearance of the colonies. If gemmiferation is reduced only for a short time to a certain extent, then the old gems, when no longer hampered by so many new intruders, grow astonishingly quick to the same size as the mother animals, and the surprising fact comes to light that the whole colony, or at least part of it, consists of cells, which are nearly all of about equal size. Such a fact was detected by Dybowsky, but was not rightly interpreted: he thinks of *Dianulites fastigiatus* that gemmation was going on in this species only in the peripheral parts, because only there the corallites are of markedly different size; but that the older parts of the colony also had been augmenting by gemmation is shown by Dybowsky's own drawings (Pl. I, fig. 3).

If thus the different size alone cannot constitute a radical difference between the several corallites composing the colony of a *Monticulipora*, the mostly observable deviating disposition of the tabulæ, as shown by Nicholson in so many forms, may perhaps constitute such a difference. With regard to the tabulæ an observation of H. v. Heider may perhaps also be of importance. He has shown that in *Cladocora* the number of septa within the calices varies greatly with the conditions under which the animals live. If the animals are well fed they produce more septa, than if the contrary is the case. May not then the same circumstance prevail with regard to the tabulæ? In a great many longitudinal sections one observes that the tabulæ are of very unequal distribution within the tubes. Partly this might be attributed to the mode of preservation of the specimens, but partly the tabulæ seem to have been in reality of very unequal distribution. We may quote in this respect the figures given by Nicholson in his book on *Monticulipora*, page 112, fig. 18 D and E, page 114, fig. 19 B and D, Pl. VI, fig. 1*g*, and many others. It is true that mostly the newly produced gems are more closely tabulate than the older animals, but as also these vary during their lifetime in this respect, we need not be astonished that the young animals placed more near the surface of the colony, and probably more vigorous than the old animals, were more freely nourished, and thus were able to deposit tabulæ more frequently.

If thus one and the same animal during its lifetime can change from the widely tabulate form into the closely tabulate one, and *vice versa*, and if the closely tabulate form of the young animals occurs only in certain species, whilst in others, as is admitted by Nicholson, it is entirely absent, it appears barely possible that a difference in the tabulation should indicate a difference in organisation. It is quite incredible that one and the same animal should change during its lifetime from an antozooid into a siphonozooid, and from the latter again into an antozooid. It is likewise incredible that for some of the *Monticuliporidæ* the closely tabulate young individuals should have consisted of siphonozooids, and in others, where closely tabulate gems do not occur, the young individuals consisted solely of antozooids, whilst in all other respects the two forms may be so nearly related to each other that even a specific distinction may be difficult.

We can well admit, that the character of the young corallites being more closely tabulate than the old ones is of a certain importance, and we admit also that Mr. Nicholson very rightly has chosen this character for the establishment of sub-divisions within the genus *Monticulipora*, but what to us appears very doubtful is, whether the interpretation given by Nicholson to this fact is correct, and from the above considerations it follows, with much probability, that in reality no dimorphism of the animals inhabiting the colonies is indicated by this fact. The circumstance that this character can be made use of for the distinction of sub-divisions, proving most evidently that it is restricted to certain forms and is not of general occurrence, is one of the strongest proofs against the supposition that we have to deal here with radical structural differences in the one as well as in the other case. By the identical mode of gemmation all the true *Monticuliporidæ* are most intimately connected together; and Mr. Nicholson also advocates strongly that all these forms should remain united in one and the same genus, and that only sub-genera should be admitted. It is now utterly improbable that in one and the same genus dimorphic as well as not dimorphic forms should be contained, as this character just constitutes one of the chief differences between *Alcyonaria* and *Zoantharia*.

Besides the interstitial tubes, which, as we have endeavoured to demonstrate, are young gems in the state of progressive development, and the true corallites, there have been distinguished by Nicholson in the *Monticuliporidæ*, yet another set of bodies which he calls "spiniform corallites." These are described as being in the beginning small, open, hollow tubes, which afterwards become filled up by sclerenchyma and then project on the surface of the corallum as little spines over the surrounding corallites. These organs are most distinctly developed in the genus *Dekayia*, E. and H., but are observable in a more or less strong degree in the greater part of *Monticuliporidæ*. Mr. Nicholson thinks them to be singularly modified corallites.

We may, in the first place, be allowed to state that these spiniform corallites appear to us to stand in a more or less close connection with the gemmation of the single colonies, but that rather different things have been placed by Nicholson under the name. In all the many cases in which we were able to observe the existence of spiniform corallites, we were convinced that these bodies do not commence their existence as little hollow tubes but are always in the beginning compact, and appear as thickening of the primary wall, generally at the places where several corallites meet together. A figure which is very instructive in this respect is that on Pl. CXII, fig. 2*d*., representing the central portion of a little stem of a Monticuliporoid coral. As is clear at a first glance on the structure of these corals, the central portion of the colony is the one which is first developed, and the cells in the centre show the most primitive development. Thus also with regard to the spiniform corallites; the central portions of the colony must show their first state of development, and if no hollows exist within them there, we can safely conclude that they are compact from the beginning. The figure quoted above shows us a number of these spiniform corallites within the central portion of the colony as compact dark spots without hollows in the middle. In the same figure, however, we see more towards the peripheral region of the colony, just where the transition between the central and peripheral regions takes place, these so-called spiniform correlates opening out and transforming themselves into little tubes. These again become more and more widened and at last become corallites of the common shape. From these observations it appears beyond doubt, that a great part of the so-called spiniform corallites are nothing but newly developed gems. As has been stated above, gemmation is always inaugurated by a thickening of the primary wall, and just this first stage is that which generally has been considered by Nicholson as the common form of the spiniform corallites. If a hollow was observed by Nicholson within these organs, then a somewhat more advanced state of gemmation was subject to his observation. The little spines, which very generally are observable on the surface of the colonies of *Monticuliporidæ* between the openings of the tubes, are nothing but the thickenings of the primary wall which, when the colony augments in size, afterwards change into gems and at last into corallites. If the surface is very well preserved, the primary wall projects as a high ridge in the middle between the tube openings, and in it the little spines are placed. Some of them are, however, always to be found in the state of opening out (see Pl. CXII, fig. 1*c*). The preservation of the specimens is not always such that the observations just described could in every case easily be made. If the primary wall of the corallites is preserved by a white sparry matrix, and cannot be distinctly made out, as very often is the case, or if gemmation is so very frequent that the original thickenings of the primary wall can no longer be followed (see Pl. CXII, fig. 2*b*, or Pl. CXIII, fig. 2*b*.) then it is not easy to identify the spiniform corallites with gemmation; but if the process has once been studied in detail then also in these latter cases the real nature of the spiniform corallites can well be made out. One mode of preservation still needs special mention, and this is the one which has been figured by us Pl. CIX, fig. 2*a*. The entire primary wall seems here to be dissolved into a number of black spots, which appear exactly like spiniform corallites, only that they are a little less distinctly circumscribed. It seems to us that Mr. Nicholson has in some cases (for instance, in ***Monticulip. tumida***, Phill.) taken this mode of preservation to represent spiniform corallites, which in reality is not the case. The real nature of these spots becomes clear from our figure Pl. CX, fig. 1*c*, where the upper right hand cornor shows well-preserved primary mural plates between the single corallites, whilst the remainder of the figure shows the same primordial walls resolved into an irregular number of dark spots, the origin of which is evidently due to the deposit of mineral matter on the original primordial wall. Such mineral deposits cannot, however, be restricted solely to the vicinity of the primordial wall, but may appear anywhere within the substance of the wall and may then be very misleading as to the structure of this wall.

Mr. Dybowsky has fallen into the same error, in uniting the two different things—the spots caused by preservation and the real thickenings of the primordial wall inaugurating gemmation—under the samo heading "Wandstränge." For instance, on his Pl. II, figs. 8*a*, 10, and 10*a* represent tho first case, whilst figs. 9*a* and 9*b* represent the second case. There is again a mingling of different things in what he calls "Wandröhrchen:" what are represented on Pl. III of his work in figs. 3 and 3*a* are certainly young gems; whilst the "Wandröhrchen" in the genus ***Trematopora*** are something widely different, organs the nature of which we cannot guess at, as we have no materials for observation.

We thus think to have demonstrated that there was only one set of animals engaged in building up the colonies of the ***Monticuliporidæ***, and that all the differences that havo been observed can well be explained by the different states of development of the single individuals.

There remains now only to make some remarks about certain structural peculiarities of the ***Monticuliporidæ*** which have not been treated of so much in detail by Mr. Nicholson. The septa in the first place require some words. These have never been observed in tho ***Monticuliporidæ***, being here even more completely absent than in the ***Favositidæ***. It is well known that in the latter family tho septa are mostly replaced by irregular protuberances, consisting of thickened parts of sclerenchyma protruding irregularly into the visceral chamber. The same is, though rarely, the case in the ***Monticuliporidæ***. Mr. Nicholson was acquainted with but few species which showed a slight development of this character (for instance, ***Mont. pavonica***, Orb.). By Dybowsky, however, there has been figured a species which has the character very strongly developed (***Orbipora panderi***, Dyb.), and we shall have to describe another species showing the same character in a rather strong degree.

The occurrence of such rudimentary septa, absolutely identical with what has been observed in the ***Favositidæ***, is one proof more of the near relation that exists between the latter family and the ***Monticuliporidæ***. Also in the *Chætetidæ* similar septa are of very general occurrence, and we perfectly concur with Mr. Nicholson when he considers the *Chætetidæ* as very nearly related to the ***Monticuliporidæ*** but forming properly a family by themselves.

A last peculiarity which is shared by the ***Monticuliporidæ*** and the ***Favositidæ*** is the frequent occurrence of cells that are apparently closed by something like an operculum. This organ has met with careful consideration on the part of Nicholson as well as of Lindström, and on the whole there can be but little added to what has been said on the point by these excellent observers. In the specimens at our disposal, however, the appearance as of an operculum is very frequently brought about by a secondary infiltration into the cells of carbonate of lime, which, as is well known, very often assumes a spheroidal shape, and no organic structure of any kind can be made out as closing the cells at their upper termination.

The ***Monticuliporidæ***, in the sense we apply to the name, are of a rather wide geological range. They begin in the silurian epoch and have been so far traced up to the permian; it is, however, very probable that the family does not stop here but extends largely into mesozoic formations, as many of the species of ***Heteropora*** that have been described from such beds are in their structure absolutely indistinguishable from true ***Monticuliporidæ***.

It is impossible now to have a clear view over all the forms that ought to be included in the family, as studies in this direction are still quite in their infancy. There are some genera which can be clearly recognised and will stand criticism, but of others this cannot be said, and thus it is extremely difficult to give an account of the forms which should be included in the family.

Three groups of forms can be recognised for the present: first, a group in which the walls of the single corallites are of a uniform thickness and the tabulæ simple; second, a group with walls of uniform thickness and vesicular tabulæ; and third, a group in which the walls of the corallites show periodical thickenings. These three groups can well be considered as forming sub-families, as each of them comprises several genera. For the first group the genus ***Monticulipora*** can be considered as typical, for the second the genus ***Peronopora***, and for the third the genus ***Stenopora***. Thus we get three sub-families: the ***Monticuliporinæ***, the ***Peronoporinæ***, and the ***Stenoporinæ***.

For the distinction of genera within these sub-families several characters can be made use of, and these characters have been selected with great ability by Nicholson. These are: first, the condition of the young corallites, whether closely tabulate or not; then the circumstance whether the state of thickening of the primordial wall, preceding gemmation, lasts for a certain time or is only quite transient; and lastly the mode of growth of the whole colonies.

The number of genera within the single sub-families is very small for the present, and we are not in a position to distribute all the different forms in proper genera. For the present the following genera may be retained:

I.—Sub-Family: *MONTICULIPORINÆ.*

1. Monticulipora, Orb., 1850: Prodr. Vol. I, p. 25. (Syn.: *Heterotrypa*, Nicholson, 1879, Pal. Tab. Cor. p. 293). The name *Heterotrypa* cannot, we regret to say, be retained, as just the forms comprised under this sub-division must get the name of *Monticulipora*, if the other sub-divisions are considered as distinct genera. The genus is characterized by the occurrence of numerous closely tabulate young corallites. The colonies are mostly arborescent. The geological range of the genus can for the present not even be guessed at. Species have been described up to the present from the silurian up to carboniferous strata.
2. Diannulites (Eichwald, 1829: Zool. special. Vol. I. p. 180), Dybowsky, 1877: Chætetid. d. ostbalt. Silurform. p. 14. (Syn.: *Diplotrypa*, Nicholson, 1879, Pal. Tab. Cor. p. 312). The name *Diannulites* must overrule that of *Diplotrypa*, even if one ignores Eichwald altogether and considers Dybowsky as the author of it. The genus is characterized by hemispherical or conical colonies, which bear on their under-surface a rather strong epitheca. The young corallites are either closely tabulate or not. The genus seems to be restricted to the silurian epoch. (That some forms placed in the genus *Diplotrypa* by Nicholson belong in reality to the *Fistuliporidæ* has been stated above.)
3. Monotrypa, Nicholson, 1879: Pal. Tab. Corals, p. 320. The genus has not been very fortunately circumscribed by Mr. Nicholson, and we rather think that those forms that bear an epitheca should be transferred to *Diannulites*, whilst those species that show thickened walls ought to be placed in *Orbipora*. The name of *Monotrypa* should be restricted to the forms without epitheca, in which the young individuals are never more closely tabulate than the rest, and the single corallites are of an angular transverse section.
4. Orbipora (Eichwald, 1829, Zoologia Specialis, Vol. I, p. 179), Dybowsky, 1877: Chætetid. d. ostbalt. Silur., p. 57. The name can well be made use of for those forms which are in all respects like *Monotrypa*, but in which the walls of the single corallites have become so much thickened that the transverse section of the corallites becomes oval or circular. Up to the present only silurian species of the genus have been described, to which must be added one species from the Salt-range.
5. Nicholsonia, Waagen and Wentzel, n. g. We create this genus to receive *Mont. pavonica* Orb., and other biserial species. A central zone, as it exists in other *Monticuliporidæ*, is here absent. The corallites start bi-laterally from a median line. Gemmation is not frequent, and thus there are also no "spiniform corallites." The typical species *Nicholsonia pavonica*, Orb. sp., is from the Cincinnati group of Ohio.
6. Dekayia, Edwards and Haime, 1851: Pol. foss. des Terr. Paléoz., p. 277. The genus is very nearly related to *Monotrypa*, and is chiefly distinct from it by the extreme development of the thickenings of the primordial wall which have received from Nicholson the name of spiniform corallites. The genus is restricted, as far as is known up to the present, to the silurian epoch.

II.—Sub-family: *PERONOPORINÆ.*

7. **Peronopora**, Nicholson, 1881: On the struct. and Aff. of Monticulipora, p. 215. This name has been created for forms which are composed of corallites with partly vesicular tabulæ and in which the young corallites are more closely tabulate and without vesicles. There are biserial as well as incrusting forms contained in the genus; but we are not sure whether a proper genus should not be created for the incrusting forms. Species of the genus have been up to the present solely observed in the Cincinnati group of Ohio.

III.—Sub-family: *STENOPORINÆ.*

8. **Geinitzella**, Waagen and Wentzel, n. gen. (Syn.: *Stenopora*, Geinitz., Schauroth, &c., *non* Lonsdale). The forms composing this genus are to a certain extent transitional between *Orbipora* and *Stenopora*. The periodical swellings of the walls of the corallites, characteristic of the genus *Stenopora*, are present but in a very reduced state, and differently developed in different specimens. The genus can be termed the representative of the *Stenoporæ* in the northern hemisphere. It has been observed up to the present only in permian strata.
9. **Stenopora**, Lonsdale, 1844: Appendix to Darwin's Volcanic Islands, p. 161; 1845, Strzelecki's Phys. Descr. of New South Wales, p. 262; (*non* Mc'Coy, Geinitz, Schauroth). Though it is stated by Nicholson, that *Stenopora* possesses mural pores, yet in the dozens of slides we prepared we were never able to detect such. It is thus very probable that Mr. Nicholson's indication is only an error of observation. If, however, the mural pores are absent, the genus cannot be placed otherwise than in the *Monticuliporidæ*. The periodical thickenings of the walls of the corallites are very conspicuous in this genus. The genus is restricted chiefly to the southern hemisphere and occurs there in carboniferous and permian strata.

These are the genera which can be distinguished for the present. Though we have no doubt that the number ought to be augmented considerably, yet this cannot be done for the moment. The microscopical studies of these forms, which have been so ably inaugurated by the magnificent works of Nicholson and Dybowsky, will have to advance much further before a more minute distinction of genera can be made out.

In the Salt-range the family is well represented, not so much by a great many different forms, as by very numerous and well preserved individuals. There occur two of the three sub-families, the *Monticuliporinæ* and the *Stenoporinæ*, each of which is represented by two genera, the first by *Monotrypa* and *Orbipora*, the second by *Geinitzella* and *Stenopora*.

Sub-family: *MONTICULIPORINÆ.*

Genus: MONOTRYPA, Nicholson.

The materials we possess of this genus are rather scanty and not in very excellent preservation. We therefore are, we regret to say, not in a position to give a more accurate description of the genus, nor to add anything new to the excellent observations published by Mr. Nicholson on the subject. Only so much we must remark, that it appears impossible to retain the genus in the extension given to it by Nicholson, for thus circumscribed it appears to be identical with some previously described genera. The single character that the young corallites are not more closely tabulate than the adult ones is too wide for the characteristic of the genus: some other features must be taken into consideration to circumscribe easily recognisable generic groups. Thus it appears to us that the forms having a well developed epitheca, placed by Mr. Nicholson under the genus, should be rather placed with *Dianulites*, Eichw., instead of with *Monotrypa*, as just one of the most typical character of the former genus consists in the presence of an epitheca, which is otherwise of rather rare occurrence within the family.

As regards the name *Dianulites*, which has been rejected by Nicholson, we cannot help stating that according to all rules of nomenclature it must take precedence of the name *Heterotrypa*, as not only was it published fifty years previous to *Heterotrypa*, but also its accurate re-description by Dybowsky dates two years further back than the introduction of Nicholson's name.

Quite the same fate would, however, be in store for the name *Monotrypa*, if it were attempted to retain this genus in the extension given to it by Nicholson. Not only that a part of it is identical with *Dianulites*, but another much larger part coincides with the genus *Orbipora*, Eichw., as redescribed by Dybowsky two years previous to the creation of the name *Monotrypa*. It is the forms of *Monotrypa* with thickened walls of the single corallites that have been named *Orbipora* by Eichwald and Dybowsky.

If then we wish to retain the name *Monotrypa* at all, we must exclude from it the forms with thickened walls, and restrict the name to those forms which have the walls of the single corallites either not thickened at all or in which the thickening is not considerable, so as to exhibit in the transverse section the shape of the single corallites always somewhat polygonal, never quite oval or circular.

The number of species belonging to *Monotrypa* is thus very considerably reduced, and it appears barely possible to indicate the exact geological range of the genus. In the Salt-range a single form belonging to *Monotrypa* has been detected. It occurs there in the lower division of the Productus-limestone.

1. MONOTRYPA MASTOIDEA, Waagen & Wentzel, n. sp., Pl. CVI, fig. 1; Pl. CXV, fig. 7.

Corallum attached with a broad extended base to foreign bodies; forming more or less high, bluntly conical elevations, which apparently do not exceed the height of 10mm. Surface of corallum smooth, without monticules. Calices polygonal, very small, mostly not more than 0·2mm. in diameter. very closely arranged with narrow spaces between. The surface is too badly preserved to show whether there were tubercles or not. Corallites tubular, either being fixed directly to a foreign body for a short distance and then becoming erect, or radiating from a short imaginary axis. Walls very thin in the interior parts of the colony, slightly thickened towards the periphery. Tabulæ tolerably numerous, irregularly distributed. Propagation very distinctly partly by intermural gemmation, partly by fissiparity. In tangential sections, "spiniform corallites" are observable everywhere in the corners of the corallites.

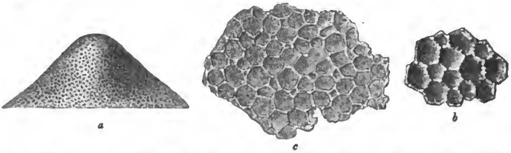

Fig. 31. MONOTRYPA MASTOIDEA, Waagen and Wentzel, n. sp.—Specimen from the lower Productus-limestone of Amb: *a*, the entire specimen, enlarged about six times; *b*, part of the somewhat weathered surface, strongly enlarged; *c*, microscopical section, not very well preserved, showing the thickenings preceding gemmation, and gems in different states of development, enlarged forty times.

This species is very characteristically distinguished from others by its bluntly conical shape and very broad base of attachment. It is, however, doubtful to us if the only specimen at our disposal shows the full development. In the whole manner of growth the present species shows a certain affinity to ***Monticulipora wesenbergiana***, Dybowsky, and as this species is partly incrusting and partly arborescent, it is not improbable that also of the Indian species an arborescent form may exist.

Locality and geological position.—The only specimen of this species that is known to us was found at Amb in the coaly sandstones at the base of the lower Productus-limestone attached to a specimen of ***Derbyia regularis***, W.

Remarks.—The present species cannot be compared in particular with any hitherto described species of ***Monotrypa*** proper, but it shows a certain affinity, as has been stated above, to ***Monticulipora wesenbergiana***, Dybowsky, from silurian strata of the Baltic provinces. The mode of growth of both forms seems to be identical, but the minute structure is considerably different. Whilst ***Mont. wesenbergiana*** shows so strongly thickened walls of the single corallites that it must be placed in the genus ***Orbipora*** of Eichwald, the Indian species exhibits these thickenings only on a very moderate scale and must thus be placed in the genus ***Monotrypa***. Thus also the specific difference of the two cannot be questioned.

Genus: ORBIPORA (Eichwald) Dybowsky.

It is barely possible to accept Eichwald as the real author of the genus, as nothing but the name is from him, his two diagnoses of the genus being absolutely useless. Thus the genus can be considered as well founded only after the careful description of it given by Dybowsky in his east-baltic silurian *Chætetidæ*.

Dybowsky characterizes the genus in the following manner: "Corallum polymorphic, corallites tubular with thick walls, which are common to the adjoining individuals, and of a lamellar structure. The lamellæ are bent convexly upward; within the walls of the corallites are string-like, sclerenchymatic thickenings; tabulæ either present or wanting."

According to the views now prevailing in these matters, this diagnosis is again not complete. Dybowsky says nothing of the structure and distribution of the young individuals, a character which has been so ably made use of by Nicholson, nor does he mention the mode of gemmation which is also absolutely required for the right determination of such things. To find out these characters we must turn to Dybowsky's drawings and descriptions of the species.

We then find that *Orbipora* is in all respects like *Monotrypa*, with the sole distinction, that the walls of the single corallites are extremely thickened, whilst they are less so in *Monotrypa*. The existence of "Wandstränge" which is much insisted on by Dybowsky is of no value whatever for the classification, as it depends, as has been shown above by us, solely upon the mode of preservation.

If this latter character, the existence of "Wandstränge," be ignored, then what has been described by Dybowsky under the name of *Monticulipora* falls for the greater part to *Orbipora*, and probably only a single species of Dybowsky's *Monticulipora* must be assigned to *Monotrypa*, the one figured on Dybowsky's Pl. III, fig. 3, which has received no specific designation from him.

That Dybowsky's *Monticulipora* cannot be identified with D'Orbigny's genus has been demonstrated conclusively by Nicholson, who has shown that the typical species of *Monticulipora* bears the characters of *Heterotrypa*, and thus is something widely different from *Orbipora* or *Monotrypa*.

Dybowsky's *Monticulipora* is in all respects identical with *Orbipora*, with the sole exception that the primary mural plate is not resolved into a number of so-called "mural strings," but is either not preserved at all or else is distinctly visible as real primordial wall.

There have been figured by Dybowsky in *Orbipora panderi* thorn-like processes from the interior of the walls which are identical with what has been called rudimentary septa in Favosites. We shall have occasion to describe similar organs in a species of *Stenopora*.

The genus *Orbipora* has a wide geological range and is represented in numbers from silurian up to carboniferous strata.

In the Salt-range we can register only a single species of *Orbipora*, which has been found there in the lower division of the Productus-limestone.

1. ORBIPORA AMBIENSIS, Waagen & Wentzel, n. sp., Pl. CXV, fig. 2.

Corallum dendroid, branches thin, not more than 2mm. in diameter, forking at intervals. Surface smooth without monticules. Calices roundish or oval, not very small, generally about 0·3mm. in diameter. Spaces between the calices comparatively broad, furnished with high crests along their middle line, and rarely with tubercles in the corners where several calices meet. Corallites tubular, irregularly radiating from an imaginary axis. Walls of the corallites very thin in the middle of the branches, but with very strong secondary thickenings towards the periphery. Tabulæ very scarce or even entirely absent. Gemmation not very frequent.

This species in its general appearance bears much resemblance to *Geinitzella columnaris*, Schl., which will be described later on in the text. Yet the present form cannot be placed in the genus *Geinitzella*, because the regular transverse wrinkling of the internal casts of the corallites of *Geinitzella* cannot be observed in the present species, and also the structure of the walls is considerably different, as no so-called spiniform corallites are developed.

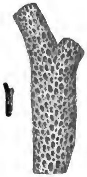

Fig. 32.—ORBIPORA AMBIENSIS, W. & W. Specimen from the lower Productus-limestone of Amb, natural size, and enlarged five times.

Locality and geological position.—A single fragment of a branch was collected in the coaly sandstones at the base of the lower division of the Productus-limestone at Amb.

Remarks.—It must be confessed that the materials of this species are very scanty and barely sufficient to characterise it thoroughly, but on the other hand the occurrence of a true *Orbipora* in the lower division of the Productus-limestone is so interesting, that we thought it worth while to describe the form more accurately. Yet we must apologise on these grounds for the briefness of the description.

Among the species of *Orbipora* hitherto described there are several which might be compared to the present species. There is principally *Orbipora arborescens*, Dybowsky, which bears a certain resemblance; the branches are, however, thicker, and the walls still more thickened than in the Indian form. Another form is *Monticulipora ædilis*, Eichwald. It needs only a look at Dybowsky's drawings of this species to be convinced that the form belongs to the genus *Orbipora*. In the thinness of the branches this silurian species very much resembles the Indian one, but the calices are much more elongately oval and placed more regularly in quincunx than in our *Orbipora ambiensis*.

That the species, though resembling *Geinitzella columnaris*, Schl., can be distinguished from it has been remarked above; the absence of those thickenings preceding gemmation that have been called by Nicholson "spiniform corallites" forms a very striking distinguishing character, and besides there is no annular wrinkling.

Sub-family: *STENOPORINÆ.*

Genus: GEINITZELLA, Waagen aud Wentzel, n. gen.

The present genus has been founded by us not only on the investigation of Indian but as well of European materials, which all belong to one and the same species, the well known *Stenopora columnaris*, Schl., which is a common form of the permian beds of Europe. For excellently preserved European materials we are indebted to the kindness of Geheimrath Geinitz of Dresden, who sent us a number of specimens from the Zechstein of Gera; they have been figured for comparison with the Indian materials on Pl. CXII of the present work.

It was noticed many years ago by the excellent observer Schauroth, that the visceral chambers of *Stenopora polymorpha*, as he called it, are provided with transverse wrinkles which are chiefly conspicuous on the internal casts, and he figures (Zeitschr. d. Deutsch. Geolog. Ges., Vol. VI, 1854, Pl. XX, figs. 5-6) two such casts showing this character in a most striking manner. In strongly enlarged microscopical sections this character is much less conspicuous, but our Plates CXIV, figs. 2*d* and 3*b*, and CXII, figs. 2*c* and 2*d* show this peculiarity also sufficiently well to give a fair idea of this transverse wrinkling. These wrinkles establish a very near relation of the forms which are provided with them to *Stenopora*, Lonsdale, and the character seems to us of sufficient importance to found on it a new genus.

Otherwise the new genus agrees in its structure almost entirely with *Monotrypa* or *Orbipora*. The first microscopical investigations of the organisms here under consideration were published by Dybowsky in 1876 in the "Verhandlungen der russischen mineralogischen Gesellschaft." His observations are, however, not quite in accordance with what we have found. Dybowsky considers as the most essential character of the genus the existence of a central cavity (Axenrohr) which extends longitudinally through the branches, and which is described in detail as bearing a distinct wall for itself and consisting of layers of different structure, etc. This "Axenrohr" we have also found in European specimens of *Geinitzella*, but there is not the slightest doubt in our case that it consists of a foreign body, on which the colony of corals has grown. In our case it is probably the spine of a *Productus;* in the case figured by Dybowsky it is probably a *Serpula* or *Serpulites*. That the branches are absolutely of the same structure as in other *Monticuliporidæ*, if the colony has not grown round a foreign body, is shown by our figure Pl. CXII, fig. 2*d*, where the central zone, as in other *Monticuliporidæ*, is perfectly well developed. Also in our figures, where the "Axenrohr" appears, sometimes layers of different structures can be observed, but they are not constant and are evidently nothing but products of fossilisation.

The colonies are very often not simple, but one colony settled on another, causing the formation of concentric layers, of which the whole corallum appears then composed. This character has been strongly insisted upon by Keyserling, and also Dybowsky lays some stress on it. This composition of concentric layers is, however, not identical, as has been rightly demonstrated by Dybowsky, with what appears in many tabulate corals as caused by all the tabulæ of the several corallites being on the same level. The concentric layers of *Geinitzella* are all perfectly independent colonies. Each colony commences with a thin basal plate of compact sclerenchyma, which is built up of the pedal plates of the several corallites grown together. This plate covers all the apertures of the old tubes and often enters even into their hollows.

Some words may be needed with regard to the figures of the genus given on Pl. CVI, figs. 1, 5, 6, Pl. CXII, and Pl. CXIII. In all the figures on these plates not representing tangential sections, the preservation of the primary mural plate or primordial wall by a white matrix is very conspicuous. Just where the thickenings preceding gemmation, which extend in these forms over very long distances, have been hit by the sections, it looks as if these were open tubes or canals, but the figure 1*e* on Pl. CXIII shows clearly that this is not the case. To the right and to the left are walls of corallites in which are no such thickenings; and in the wall to the right the primordial wall is preserved as a dark line. The thickenings indicated in white have a finely fibrous structure, and are not simply sparry or filled with rock matrix as they should be if they were tubes. Yet more convincing in this respect are the figures on Pl. CXIV: in fig. 1*d* we see the thickenings dissolved into a series of black spots, whilst figs. 2*d* and 3*b* exhibit in what different manners the primordial wall can be preserved.

The thickenings preceding gemmation, which have been called spiniform corallites by Nicholson, are also remarkable in other respects in these forms. If the wall separating two adjoining corallites is not very thick, these thickenings can press one side of the wall into the interior of the visceral chamber of one of the corallites, whereby often a bi-lobed form of the corallites in the transverse section is brought about (compare fig. 4, Pl. CXII), a circumstance which has been figured already by Geinitz in his *Stenopora columnaris* and which has been misapprehended by Dybowsky in his paper on *Fistulipora lahnseni.*

In fig. 1*c* of Pl. CXIV the thickenings show a very peculiar mode of preservation, but this is quite exceptional and can be explained by comparison with the longitudinal section, fig. 1*d*. Again another mode of preservation causes the dendritic figures that have been observed and drawn by Dybowsky.

Thus we can define our new genus in the following manner: Corallum creeping or arborescent, composed of more or less cylindrical corallites which augment by intermural gemmation or fissiparity and are transversely wrinkled. The walls of the corallites in arborescent forms are strongly thickened in the peripheral parts. The thickenings of the primordial wall preceding gemmation project from the surface of the colonies as little spines, which surround the apertures of the corallites. Tabulæ very rare or nearly absent.

The genus is most nearly related on the one hand to *Orbipora* (Eichw.), Dybowsky, and on the other to *Stenopora*, Lonsdale. From the first of the two it is distinct by its transversely wrinkled corallites and the greater scarcity of tabulæ, and from the second by the absence of the strong periodical thickenings of the walls of the corallites, so very conspicuous in *Stenopora*.

In the Salt-range the genus is represented by two species, one of which is identical with the well known *Geinitzella columnaris*, Schloth. sp., from the permian beds of Europe.

1. Geinitzella columnaris, Schloth. sp., Pl. CVI, figs. 5, 6; Pl. CXII, figs. 1-5 (European specimens); Pl. CXIII, figs. 1-4; CXV, fig. 1.

1813. *Coralliolites columnaris*, Schlotheim: Mineralog. Taschenb., p. 59.
1820. *Encrinites ramosus*, (Brachia) Schloth.: Denkschr. Akad. Münchn., Vol. VI, p. 23, pl. III, fig. 10.
1842. *Ceriopora milleporacea*, Kutorga: Verhandl. Mineralog. Ges. St. Petersburg, p. 28, pl. IV, fig. 5.
1845. *Stenopora spinigera*, Lonsdale: Murch. Vern. Keys., Russia and the Ural mtns., p. 631.
1848. *Stenopora mackrothi*, Geinitz: Verst., p. 17, pl. VII, figs. 8-10.
1848. *Alveolites producti*, Geinitz: Ibid., p. 19, pl. VII, figs. 28-31.
1850. *Stenopora columnaris*, (Schl.) King: Monogr. Perm. Foss., p. 28, pl. III, figs. 7-9.
1850. *Alveolites buchiana*, King: ibid., p. 30, pl. III, figs. 10-12.
1854. *Stenopora polymorpha*, Schauroth: Zeitschr. d. Deutsch. Geolog. Ges., Vol. VI, p. 541.
1854. *Stenopora spinigera*, (Lonsd.) Keyserling: in Schrenk's Reise, II, p. 99, pl. II, figs. 1, 2.
1861. *Stenopora columnaris*, (Schloth.) Geinitz: Dyas, I, p. 113, pl. 21. (excl. fig. 20).
1875. *Stenopora tuberosa*, (Gein.) Toula: Spitzbergen; Neu. Jahrb., 1875, p. 247, pl. X, fig. 4.
1876. *Stenopora columnaris*, (Schloth.) Dybowsky: Verhandl. russ. mineralog. Ges. St. Petersburg.

The external shape of the corallum is very variable, sometimes incrusting foreign bodies, often cylindrical, and sometimes dendroid. The branches do not often become thick, up to 5mm. diameter, but generally are much thinner, about 2mm. Calices round, oval, or polygonal, mostly of very unequal sizes. There are no clusters of larger tubes, nor smooth spaces between the calices. The corallites are mostly round or oval in the peripheral parts of the colony and polygonal with thin walls in the central parts. They are distinctly wrinkled or contracted transversely at intervals, either for their whole extent or only in the peripheral parts where the walls become considerably thickened. The most striking character in thin sections is the remarkably compact nature of the thickenings of the primordial wall, the terminations of which project as spines from the surface of the colonies and which afterwards are transformed into gems. If the specimens are well preserved these thickenings can be followed for a considerable length; they are then always preserved by a white matrix and their extremely compact nature can be well made out. If the preservation is less favourable they show a somewhat dendritic appearance as has been described by Dybowsky. These dendritic masses, however, appear only when the substance of the thickening is quite dissolved and replaced by mineral matter. That these compact thickenings are not a product of preservation solely but are really a specific feature of the form here under consideration, is shown most clearly by the specimens that have been figured by us on Pl. CXII and CXIII, where the same character is exhibited in absolutely the same manner by European as by Indian specimens.

When the surface of the specimens is perfectly preserved, as happens rather rarely, these compact thickenings project as large spines. What development these spines may attain is shown by our figure Pl. CXII, fig. 3, where the surface of one colony has been covered by another newly formed colony, and where the surface of the old colony has thus been perfectly preserved. The specific name of "*spinigera*," created by Lonsdale for this form, was thus a very appropriate one.

Several varieties have been distinguished within the species by Geinitz, a proceeding that was most appropriate. The forms belonging to the species can be brought very conveniently according to the external appearance into three groups; one, to include incrusting forms, another for arborescent colonies, and a third forming tuberous masses. With this latter group *Stenop. crassa*, Lonsd., was united by Geinitz, but we think that this should not be done, as we consider *Stenop. crassa* as a distinct species. Some of these varieties have been found in India: we are inclined to distinguish the following:—

a. Var. incrustans, Gein., Pl. CVI, figs. 5-6. Besides the peculiarity that it is incrustating, this variety shows also generally the character that it produces very few gems, which caused Mr. King to describe it under the name of *Alveolites buchiana*. Exactly the same peculiarities we find in the Indian specimens figured on Pl. CVI.

b. Var. ramosa multigemmata, Pl. CXII, fig. 2*a*, 2*b*, Pl. CXIII, figs. 2*a*, 2*b*, 3, 4. The variety "*ramosa*" of Geinitz shows very different appearances according to the scarcity or profusion of gems, and it seems convenient to make a difference between the two forms. The "*multigemmata*" has large interspaces between the openings of the full-grown corallites, and these spaces are covered by numberless little gems or thorns, according to the state of development. This variety occurs also in absolutely the same manner in Europe as in India.

c. Var. ramosa sparsigemmata, Pl. CXII, figs. 1*a*, 1*c*, 4., Pl. CXIII, figs. 1*a*, 1*c*, 1*d*. In this variety the apertures of the full-grown corallites are much closer together than in the preceding and single gems appear between them. This variety also is common to Europe and India.

The *Var. tuberosa*, that was distinguished by Geinitz and that is not of very rare occurrence in Europe, has up to the present not been detected in India.

Locality and geological position.—The species here under consideration is about equally distributed throughout the middle and upper divisions of the Productus-limestone. It has been found at Khura in the top-beds of the middle division, and west of Khura in the lower beds of the upper division. At Chidru it is not rare in the Cephalopoda-bed, whilst at Káfirkot again it has been found in the middle region of the middle division. From the trans-Indus continuation of the Salt-range there were also some specimens contained in Dr. Verchere's collection, but the exact locality whence they came is not known. It is not possible to give numerical indications as to the frequency of the species at different localities, as an exact determination of these things without microscopical sections is impossible, and it is at the same time impossible to make such sections of every specimen. So much, however, can be said that the species is rather common, and most so west of Khura.

Remarks.—The occurrence of this well known permian species in the Salt-range is again of great geological interest. That the Indian specimens are absolutely identical with the European ones is shown by our plates, where specimens of both countries are placed side by side.

2. GEINITZELLA CRASSA, Lonsdale, sp., Pl. CXIV, figs. 1, 2, 3.

1845. *Stenopora crassa*, Lonsdale: in Mürch. Vern. Keys., Vol. I, p. 633, pl. A. fig. 12.
1846. *Stenopora crassa*, (Lonsd.) Keyserling: Petschoraland, p. 183.
1854. *Stenopora crassa*, (Lonsd.) Keyserling: in Schrenk's Reise, vol. II, p. 99 (*pars*).
1861. *Stenopora columnaris*, Schloth. *var. tuberosa*, Geinitz (*pars*): Dyas vol. I, p. 115, pl. XXI, fig. 20 (*excl. cet.*).
1875. *Stenopora ramosa* (Gein.) Toula: Spitzbergen; Neu. Jahrb., 1875, p. 246, pl. X, figs. 2-3. (*male*).

Though the internal structure of the original specimens of this species is not known, yet we venture to identify with Lonsdale's name a number of Indian specimens which are distinct from *Geinitzella columnaris* by a much more robust shape and by some internal characters.

The corallum is always arborescent with very thick cylindrical branches, which have a diameter of mostly at least 10mm. They are sometimes, but not always, composed of different colonies, which are deposited one above the other. Calices always rounded, oval or circular, of very variable sizes, often only a few of the smaller sort being disseminated between the larger ones, but sometimes with a great number of smaller intercalated between the larger calices, so that also in this species a variety with gems in profusion and another with only few gems could be distinguished. The surface only very rarely shows projecting spines.

In thin sections the corallites appear polygonal, with thin walls in the centre of the stems, but becoming considerably thickened towards the periphery, whereby an oval section of the corallites is brought about. Within the thickened part of the walls the thickenings of the primary mural plate preceding gemmation become also in this species conspicuous, but quite differently from those in *Gein. columnaris*. They are much less compact and more or less nodular, often interrupted, and are transformed into gems as soon as they reach the surface and find space for the development of new individuals. Therefore the existence of spines on the surface is of very rare occurrence in this species. Though this latter character can be found as well on *Gein. columnaris*, yet in that species it is caused by preservation solely, whilst in the present one it is a result of the structural peculiarity of the thickenings preceding gemmation. Septa-like processes occur sometimes in this species.

These characters, together with the more robust shape of the whole colony, seem to us sufficient to distinguish these forms from *Gein. columnaris*, Schloth.

Locality and geological position.—The greatest number of specimens (about a dozen) of this species were collected by Mr. Wynne at Jabi in the upper division of the Productus-limestone. Another specimen was found at Chidru in the Cephalopoda-bed, and besides this there is yet a doubtful specimen from the middle Productus-limestone of Káfirkot.

Remarks.—It is somewhat hazardous on our part to identify the Indian specimens with Lonsdale's *Stenop. crassa*, which was described originally from permian beds of N. E. Russia. Lonsdale's species has been identified by most authors with *Stenopora columnaris*, Schloth., and it seems to us that this identification is quite correct so far as specimens of S. W. Europe are concerned. The very robust form of the true *Gein. crassa*, Lonsd., seems to us restricted to N. E. Europe (Russia) and Spitzbergen and not to occur in Germany or England.

In external shape the Indian specimens are absolutely identical with the Russian ones, and there is every probability that also the internal characters will prove identical.

The evidence before us seemed not sufficient to warrant the introduction of a new name for the Indian coral, and as the probability of its identity with *Geinizella crassa* was very great, we decided on putting the Indian form under this name.

Genus: STENOPORA, Lonsdale.

Under the name of *Stenopora* very different things have been described. It was thus a very meritorious proceeding on the part of Mr. Nicholson, that he returned to Lonsdale's original description and to the study of original Australian specimens; from his investigations we know that all the forms described by Mc'Coy, Geinitz, and others under the name do not belong to the Australian genus, but must be distributed in other genera.

In the Salt-range, specimens agreeing in all respects with the true Australian *Stenopora* are not very rare, and we must admit the plentiful representation of the genus in India.

According to our materials the diagnosis of the genus may be drawn up in the following manner:

Corallum incrusting, arborescent, foliaceous or hemispherical, fixed by its base to foreign bodies, composed of tubular corallites, which are nearly vertical in the centre of the corallum and radiate thence on all sides towards the surface. The corallites are polygonal in the centre of the corallum, with thin walls and very closely packed together; in their radiating peripheral part they become cylindrical and their walls show regular transversely annular thickenings, which occur in the same manner and at equal distances in a great number of adjoining corallites. These thickenings alternate on the inside of the corallites with periodical contractions of the walls. There are yet other thickenings that extend longitudinally within the walls as in other *Monticuliporidæ;* they are the thickenings that precede gemmation, and project on the surface of the corallum as little spines between the single corallites. The calices on the surface of the corallum are partly quite open, partly closed by a kind of hemispherical lid. They are of rather unequal sizes. Tabulæ are present within the corallites at very irregular distances, but they are either concave or convex, not flat. Mural pores and distinct well-developed septa are absent. The corallum is composed of several concentric layers each of which is a separate colony. The single colonies increase by intermural gemmation chiefly.

From this diagnosis it appears that the structure of the genus is absolutely like that of other *Monticuliporidæ*, and that the only difference for instance between *Orbipora* and *Stenopora* consists in the periodical annular thickenings exhibited by the walls of the corallites in the latter genus, whilst in *Orbipora* the thickening of the walls in the peripheral parts of the corallum is equal throughout.

These periodical thickenings of the walls must naturally cause a different aspect in the tangential sections, according to whether they cut just through these thickenings or not. In the first case the interiors of the visceral chambers appear reduced to comparatively thin tubes, which are encircled by a ring of sclerenchyma, which often can be distinguished as composed of concentric lamellæ (Pl. CIX, fig. 2*a*). If however the section cuts through the intervals between the thickenings, one sees also generally a ring of sclerenchyma within the dark lines of the primary mural plates (Pl. CX, fig. 1*c*, Pl. CXI, fig. 1*a*), but this ring is either of very moderate thickness or is even almost entirely absent, so that the visceral chambers appear even more or less polygonal. The whole section appears then to a certain extent as if taken from the central part of the corallum.

The inexplicable facts mentioned by Nicholson and Etheridge with regard to the present genus in Ann. and Mag. Nat. hist., Ser. V, vol. IV, p. 272, find a very natural explanation in what has been said of the preservation of the walls of the *Monticuliporidæ* in general in the introduction to the family. The appearance in tangential sections, as if the walls of the several corallites were not in contact throughout, is brought about solely by bad preservation. That the walls are in reality everywhere in contact is shown conclusively by our figures.

The fact that on natural fractures the tubes seem to be in contact for short distances only is caused by the circumstance that in *Stenopora* the substance of the walls of the corallites is very easily destroyed, and that then in natural fractures the internal casts of the tubes are exposed and not the tubes themselves. These internal casts show periodical constrictions, corresponding to the periodical thickenings of the walls; the thin parts of the walls alternating with the thickenings are then often preserved, and at those places the casts of the tubes appear to be in contact.

Longitudinal sections in which the walls of the corallites are perfectly well preserved show conclusively that they are in perfect contact throughout, and that the periodical thickenings, like the thickenings of the walls of other *Monticuliporidæ*, are made up of doubly conical layers of sclerenchyma, which meet in the middle along the primary mural plates.

A most fundamental difference between *Stenopora* and the *Monticuliporidæ* consists, according to Nicholson and Etheridge, in the existence of mural pores in the former genus. Mons. de Koninck concurs in this respect with the above authors, and consequently transfers the species *Stenop. ovata*, Lonsd., to the genus *Favosites*.

As regards Mons. de Koninck's observations, they were made evidently on internal casts, as his figure most distinctly exhibits. Now such casts are certainly not very apt for the observation of such fine structures as mural pores, and an error is very easily made. Not much better seem to have been the materials on which Messrs. Nicholson and Etheridge operated. They state that the mural pores could be most easily seen on the outside of the tubes, if examined with the microscope. Now the outside of the tubes is only exposed distinctly on weathered fractures or on fractures of specimens which have been subject already to a certain extent to weathering; quite fresh specimens always show fractures which either do not expose the outside of the tubes, or on which nothing at all can be seen, except by means of a preparation of thin slides. On weathered surfaces, however, the walls of the tubes are always so much deteriorated that openings may easily appear where originally there were none. On weathered fractures we frequently were in a position to observe such openings; they were, however, decidedly of a secondary origin. The figure reproduced by Nicholson on page 81 of his work on *Monticulipora* represents only an internal cast, where the substance of the walls has entirely disappeared. The pores are evidently nothing but accidental grooves. As regards the longitudinal sections figured by Nicholson and Etheridge, in which mural pores are said to be visible, we have a great suspicion, as they appear in the middle of the visceral chamber, that these pores are nothing else but what we figure Pl. CXI, fig. 1*c*, that is, the transverse section of some of those protuberances which have been called rudimentary septa in *Favositidæ* or *Chætetidæ*. Other longitudinal sections, like those of *Stenop. howsii* or *Sten. tasmaniensis*, show no trace of mural pores. Among the great number of microscopical sections we prepared of species of the present genus, there is certainly not a single one that shows a trace of a mural pore.

A word must yet be said about the tabulæ. These are very scarce in the Indian species of the genus, and at the same time they are very strongly curved. In other species they seem to be more frequent, and in the carboniferous *Stenop. howsii* Nicholson has described incomplete tabulæ which bear in the middle a round perforation. This character is certainly not of general occurrence in the genus.

The genus has been observed to occur up to the present in the mountain-limestone of Europe and in beds of the age of the coal-measures of Australia. To these are added four species in India which are mostly of permian age. One of these is identical with an Australian form.

1. Stenopora ovata, Lonsdale, Plate CX.

1844. ***Stenopora ovata***, **Lonsdale: in Darwin's Geol. Obs. Volc. Islands, p. 163.**
1845. ***Stenopora ovata***, **Lonsdale: in Strzelecki's Phys. descr. of New South Wales, p. 263, Pl. VIII, fig. 3*a*, *b*.**
1872. ***Monticulipora tumida*** (pars) **Koninck: Nouv. Rech. Terr. Carb. Belgique, p. 143.**
1877. ***Favosites ovata***, (Lonsd. sp.) **Koninck: Pal. Nouv. Galles du Sud., pt. III, p. 156, Pl. III, fig. 5.**
1879. ***Stenopora ovata***, (Lonsd.) **Nicholson and Etheridge: Ann. Mag. Nat. Hist., Ser. V, vol. IV, p. 274, Pl. XIV, fig. 1.**

Corallum in the beginning incrusting, later on arborescent with cylindrical and forking branches. Thickness of the branches very variable, according to Mons. de Koninck varying between 3 and 15mm; but generally not more than 9mm. in diameter. Branches often composed of several successive colonies, forming concentric layers one above the other. Surface smooth without monticules or maculæ. Calices rounded with acute margins on which often little spinules in varying numbers are placed; many smaller calices intercalated between larger ones. Corallites tubular. Walls considerably thickened at intervals, and presenting in longitudinal sections the appearance of a string of beads. Thickenings either narrowly annular or broad, both sorts alternating indiscriminately. Six to ten such thickenings within a length of one line (2·2mm). Tabulæ present, but very scarce.

In internal casts the tubular corallites appear alternately swollen and constricted, like a string of beads, according to the impressions that have been left behind by the periodical thickenings of the walls.

The calices on the surface of the colonies are of an extreme fineness. There are at least three within the distance of 1mm.

Locality and geological position.—The species is not a very common one in the Salt-range, nevertheless it has a rather large geological range. It has been found in the middle Productus-limestone trans-Indus at Kiri, and in the upper Productus-limestone at Nanga and at Jabi, above the Cephalopoda-bed. Everywhere the species appears to be rather rare.

Remarks.—The present species was originally described from Australia, from beds which must be placed on a level with the coal-measures of Europe. Though the Indian specimens occur in strata of permian age, yet it seems to us that they cannot well be distinguished from the typical Australian form. It is true, there exist some slight discrepancies, but they seem to us not quite sufficient for the distinction of a new species. Nicholson and Etheridge say that in the Australian specimens generally there are only six swellings of the walls within the distance of one line, whilst in our specimens very often more than six, up to ten, occur; but as the number is very variable, and as it appears also from Lonsdale's original drawing that these swellings even in Australian specimens are very unequally distributed, we thought it not fit to consider this variability as a sufficient character for the distinction of a species. Another discrepancy is of still less importance; this is the absence of the little spines on the surface of the Indian specimens. Whoever knows how much the appearance of the exterior of a colony depends on preservation will readily ignore this peculiarity.

2. Stenopora nicholsoni, Waagen and Wentzel, n. sp., Pl. CIX.

Corallum thick, cylindrical, bifurcating, thickness of the branches about 15mm. The calices are mostly about 0·3 mm. or somewhat less in diameter. They are generally not of very unequal size, often closed by a hemispherical calcareous mass, in which a hole appears in the middle when weathered. There are in the specimens at our disposal no, or only very few, small spines or tubercles surrounding the calices. Corallites tubular, in the centre of the colony polygonal, in the peripheral parts more or less rounded or oval. Walls thin in the centre of the branches, in the peripheral parts irregularly thickened at intervals, and appearing in the longitudinal section like strings of small differently shaped beads. There are within the length of one line (2·2 mm.) 14 to 16 such thickenings. Thickenings of the primordial mural plate preceding gemmation are not very numerous. Tabulæ scarce, very strongly vaulted.

On natural fractures of the stems the substance of the walls has generally entirely disappeared by weathering. The corallites appear then in the centre as angular columns separated from each other by deep furrows, and in the peripheral parts they look like strings of beads, alternately swollen and contracted. The swollen parts of these internal casts are generally on the same level in adjoining corallites and approach each other very closely, whilst in the contracted parts they recede. Now between the swollen parts very often the substance of the walls is still partly preserved, and the adjoining corallites appear as if blended together at these places, whilst in the intervals the wall-substance has been quite destroyed and gaps or holes appear, and it looks as if the corallites were here not in contact but widely apart from each other.

Locality and geological position.—This is a very rare species; only a single specimen of it has been detected up to the present. This was found in the upper Productus-limestone east of Katwáhi. This specimen is also so far remarkable in being incrusted at its upper extremity by *Stenop. ovata*, Lonsd.; all the lower part, however, is solely *Stenop. nicholsoni.*

Remarks.—The present species is most nearly related to *Stenop. ovata*, Lonsd., for which it could easily be mistaken. The chief difference consists in the number of swellings exhibited by the walls. Whilst in *Stenop. ovata* as a rule only six such swellings are observable within a length of one line, which number only exceptionally amounts to 10, there are in *Stenop. nicholsoni* regularly 14 to 16 such swellings within the same length. The striking difference that exists in this respect between the two species is most clearly exhibited by fig. 3 on Pl. CIX, where the interior part consists of *Stenop. nicholsoni*, whilst on the outer part *Stenop. ovata* forms an incrustation.

Other species can barely be compared to the present one. *Stenop. tasmaniensis*, Lonsd., has a still much smaller number of swellings of the walls; *Stenop. jacki*, Nich. and Etheridge, is a far more elegant species, with much thinner branches; and *Stenop. crinita*, Lonsd., forms tuberous masses, with corallites having much less numerous constrictions.

3. STENOPORA CHÆTETIFORMIS, Waagen & Wentzel, n. sp., Pl. CXI.

Corallum cylindrical, simple or forked, diameter of the branches 7 to 13 mm. Calices rounded, of not very different sizes, generally about 0·3mm. in diameter. Interspaces between the calices either carinated, if well preserved, or with little tubercles or grooves, according to preservation or different specimens. Corallites tubular, polygonal in the beginning, but very soon getting thickened walls and then exhibiting a roundish or oval section; ascending at first vertically and then very slowly bending outward by degrees to reach the surface at about right angles. Walls at first thin, but very soon, already in the vertically ascending part of the corallites, showing periodical thickenings of which 9 to 12 can be counted within a length of one line (2·2mm.). Interiors of the visceral chambers provided with numerous, very irregularly distributed, protuberances identical with what has been called in *Favositidæ* and *Chætetidæ* "rudimentary septa." Tabulæ scarce.

The structure of the walls is very visible in the preparations we have made of the species. The primary mural plate is preserved as a thin black line, and the thickenings of this plate, which generally precede gemmation, are preserved by a white and very compact matrix, quite in the same manner as in *Geinitzella columnaris* described above. The thickenings of the walls are very distinctly composed of doubly conical layers. The thickenings themselves are very irregular. In every section the protuberances of the walls, or "rudimentary septa," form a very conspicuous feature. They are of very variable development, sometimes short and thick, sometimes thin, long, and straight, sometimes bent upward, but always they are of an approximately circular section. The bent nature of these protuberances often causes them in tangential sections to appear in the middle of the visceral chambers, without being apparently united to any of the walls (see fig. 1*b* and 2*c* of Pl. CXI). A very strange appearance is presented by them when cut by a longitudinal section just at the base on the surface of the wall. They appear then as small circular sharply defined spots which might well be compared to mural pores, but one sees distinctly that they are not hollow but that the substance of the wall passes compactly below them (Pl. CXI, fig. 1*c*).

The distribution of these protuberances is extremely irregular. Sometimes they are united in little groups, sometimes they are single, and there are also large stretches of wall which bear no protuberances at all.

The tabulæ are scarce in this species also, but they are less strongly vaulted than in *Sten. nicholsoni.*

Locality and geological position.—This is the most common species of *Stenopora* occurring in the Salt-range. The species seems to be restricted to the upper Productus-limestone and has been found in numerous specimens at Khund Ghat and at Jabi, above the Cephalopoda-bed.

Remarks.—It is barely necessary to indicate how the present species could be distinguished from its congeners, as in thin sections the difference from all other species is extremely striking. Without thin sections, however, this species can as little be recognised as all the others, as there are no external characters upon which the internal ones could be judged.

4. STENOPORA HEMISPHERICA, Waagen & Wentzel, n. sp., Pl. CVI, fig. 2.

Corallum hemispherical, forming large thick masses. Calices roundish or more or less polygonal, very small, generally not more than 0·2mm. in diameter, of not very unequal sizes. Spaces between the calices narrow with a sharp edge, sometimes with tubercles, chiefly in the corners where several calices meet. Corallites tubular, radiating in all directions from one point, with thin walls in the middle, and slightly thickened ones towards the periphery. Walls with periodical swellings, which are, however, not very strongly prominent, in accordance with the moderate thickening of the entire walls. There are four to six such swellings within the distance of one line (2·2mm.). Gemmation not very frequent. Tabulæ present but scarce.

The specimen of this species is, we regret to say, in a rather bad state of preservation, and we are therefore unable to give figures of the thin sections we prepared. Though all the characters mentioned in the above diagnosis can be made out, yet this can be done only with difficulty.

The specimen from which the above diagnosis has been drawn up is 24mm. high and 21mm. broad.

Locality and geological position.—The only specimen of the species that has been found up to the present was collected at Amb, in the dark sandstones at the base of the lower Productus-limestone.

Remarks.—The black coaly sandstone in which this species is preserved is not very favourable for the preservation of finer details, and thus the description of the species must be rather brief. The whole mode of growth indicates at once a species entirely different from all those previously described, and reminds very much of *Favosites.*

Among the species described by Lonsdale from Australia *Stenop. informis* seems to be rather nearly related to the one here under consideration, as it also forms tuberous or hemispherical masses, but Lonsdale says, that the diameter of the internal casts of the tubes in the Australian species is about a quarter of a line, a diameter which so far deviates from the diameter of the corallites in the Indian specimen, it being nearly three times as large, that we do not think it possible to unite the Indian specimen with *Stenop. informis.*

Of the other species of the genus hitherto described apparently none can be compared more in detail to the present one, all of them exhibiting an entirely different mode of growth.

Sub-order: TETRACORALLA, *sive* Rugosa.

Family: *EXPLETA.*

Sub-Family: *PLEONOPHORA.*

Genus: LONSDALEIA, McCoy.

The materials of rugose corals occurring in the Salt-range are very limited, being restricted to a few species, and thus we are not in a position to add any new facts with regard to the general classification of the whole sub-order. We therefore simply accept Dybowsky's classificatien, as this seems to us the most natural one that has been proposed up to the present. It has also been introduced in Zittel's Handbook.

As regards the genus *Lonsdaleia* itself, there has been published a circumstantial description and re-definition of it by Thomson and Nicholson in the Ann. and Mag. Nat. Hist., 1876, and the statements there published, chiefly with regard to the historical account, barely need any further remarks.

Yet with regard to the definition of the genus, it seems to us that the authors confined themselves too exclusively to the facts deducible from the few species of which they had been able to prepare thin sections; so that if one were to adhere strictly to the definition as proposed by Thomson and Nicholson, even the greater part of the species described by McCoy himself under the name would have to be excluded from the genus.

The character upon which the greatest stress is laid by Thomson and Nicholson is the circumstance, that in the species investigated by them the septa are restricted to the median tabulate portion of the calices and do not reach the outer wall, except perhaps sometimes in a rudimentary and imperfect state; the outer portion of the calices being occupied by an irregularly vesicular tissue. Among the numerous slices we prepared of the species of *Lonsdaleia* that occur in the Salt-range, we have however found that in different calices of one and the same corallum this character varies greatly. In some of the calices the vesicular tissue occupying the outer zone is well developed, and the septa stop where this tissue begins, thus not reaching the outer wall; while in other calices, and this occurs in the majority of cases, the septa very distinctly reach the outer wall. Even in one and the same calix one side shows sometimes the vesicular tissue and short septa, whilst the other is provided with septa reaching distinctly to the outer wall. We have figured such a case of development on Pl. C, fig. 6. This has, however, already been very often observed; Quenstedt, for instance, figures in his Petrefaktenkunde Deutschlands, Abth. I, Vol. VI, Pl. 162, fig. 32, a specimen of *Cyathophyllum crenulare*, Phill. (as he calls it), which shows in some of the calices septa reaching to the outer wall, whilst in others they are separated from this wall by a distinct zone of vesicular tissue. Thus we think that too great stress should not be put on the character of the septa reaching the outer wall or not. It cannot be denied that numerous vesicles, or even a vesicular tissue, is always present in the genus *Lonsdaleia*, and our figures, chiefly the longitudinal sections, Pl. C, fig. 4 and Pl. XCIX, fig. 2*c*, very distinctly show such, but they are generally, in the Indian species at least, not developed in such an extreme manner as to obliterate the septa.

Another organ which needs some consideration is the so-called accessory wall, which very often separates the vesicular zone from the central tabulate area. In the majority of species of *Lonsdaleia* this wall is very conspicuous, but in others it is not, as has also been stated by Nicholson. Generally, the accessory wall appears where the secondary septa terminate; sometimes, however, it coincides with the termination of the primary septa and then approaches very close to the columella. In all the species of *Lonsdaleia* septal dissepiments are of rather frequent occurrence; if now these are arranged so as to form a circular zone, then an accessory wall is formed, if not, then no accessory wall is produced. This mode of production of the accessory wall also explains the great variability that exists with regard to its position in different species. Nevertheless, the existence and position of such an accessory wall seems of greater value for classification than the existence or absence of a vesicular tissue in the peripheral zone of the single calices. Whilst this latter varies within one and the same corallum in the different calices, the former appears very characteristic for certain species, and according to the development and position of the accessory wall several groups of forms may be distinguished within the genus. Whether the accessory wall is rather removed from the columella or in close proximity of it, it always marks off a central zone, which is solely occupied by tabulæ, and where vesicles are absolutely absent; whilst the vesicles again appear only outside of the accessory wall. The septa are generally not stopped by it, but extend also outside of it.

Within the accessory wall extends the tabulate area, as it is called by Thomson and Nicholson. This area is of very varying extent, sometimes broad, sometimes very narrow, or even sometimes entirely filled up by the extremely thick columella. The tabulæ are mostly rather closely set, more or less horizontal or ascending towards the outer region of the calix, and are sometimes slightly vesicular.

The very thick columella has always a structure of its own, independent of the remainder of the calix. Generally it is so compact that it weathers out separately, and appears then, if separated from the rest, as a thin rod. Looked at with a lens, this appears longitudinally striated, but the striæ are sometimes twisted like the thread of a screw, sometimes not, and in one and the same colony calices with twisted, and others with straight, columellas may be found. If examined under higher magnifying powers in thin sections the structure of the columella appears very peculiar. In one and the same colony the centre is sometimes occupied by a lamellar plate, sometimes not, from which waving lamellæ in irregular numbers radiate in all directions. These radiating lamellæ are always present, and cause either the longitudinal striation or the twisted appearance of the columella. Between these, in transverse sections, numerous dissepiments appear, which are shown by longitudinal sections to form regula tabulæ, which are sometimes somewhat vesicular as in Pl. C, fig. 4, or quite regularly arranged, as in Pl. XCIX, fig. 2*c* or Pl. CI, fig. 1*d*, 3*c* (these latter figures have been by accident inverted, upside down). These tabulæ are of a conical shape with the apex directed upward towards the visceral chamber of the animal. We see from all this how variable the structure of the columella even in one and the same colony may be; and under these circumstances it may be termed a very fortunate proceeding on the part of Prof. Lindström, when, in his "Index to the generic names applied to the corals of the palæozoic formations," he considers the names *Dibunophyllum*, *Aspidophyllum*, and *Rhodophyllum* of Thomson and Nicholson as synonyms (partly with a query, partly without) of *Clisiophyllum*.

The propagation of the forms belonging to the genus *Lonsdaleia* is a kind of gemmation that comes within what has been called "tabular gemmation" by Koch. This gemmation occurs in the ordinary manner in the astræiform species, but is modified to a certain extent in the fasciculate forms. Both modes of gemmation have been figured by us, the first Pl. C, fig. 3*a*, the second Pl. CXV, figs. 3, 4.

In the Salt-range the genus *Lonsdaleia* occurs in very great numbers, but though the individuals are plentiful yet the number of species is limited.

We can distinguish two groups of forms, both having but little affinity to hitherto described species. In one of these groups the tabulate area is very small, no proper accessory wall exists, nor any vesicular tissue in the peripheral parts. In the other group the tabulate area is entirely filled up by the enormously thick columella.

The first group is represented by two species, which both are astræiform, and rather nearly related to each other, forming together a little group which will best be termed, Group of *Lonsdaleia salinaria*, W. and W.

The second group contains again two species, which are in many respects quite aberrant forms.

All the species of *Lonsdaleia* occurring in the Salt-range have been found in the coral-limestones of the middle Productus-limestone, only one species extending also into the upper division.

GROUP OF *LONSDALEIA SALINARIA*, Waagen and Wentzel.

1. LONSDALEIA SALINARIA, Waagen and Wentzel, n. sp., Pl. C, figs. 1, 3, 4.

Corallum astræiform, forming large irregular masses. Corallites prismatic, five to seven-sided, of somewhat unequal size, generally 9 to 10mm. in diameter, separated from each other by well developed exothecal walls. Calices in the peripheral region but little excavated, with a more strongly deepened central part surrounding the columella. Columella not extraordinarily thick, very strongly projecting, either round or slightly compressed laterally, provided with numerous vertical lamellæ, which are generally not twisted. The projecting part of the columella is very easily destroyed by weathering (Pl. C, fig. 1*d*), and even the entire calices are often quite smoothed down by the same process (Pl. C, fig. 1*e*). Of primary septa there are about 20 to 24 (Pl. C, fig. 3*a*), between which an equal number of secondary and tertiary septa are intercalated, each of them shorter according to its position. None of the septa reach the columella, all stopping short of it, though approaching it very closely. Well-preserved calices give an impression as of a secondary wall from which the calices suddenly deepen, but in thin sections nothing of the kind can be observed.

In thin sections it is seen that the septa extend uninterruptedly from near the columella to the outer wall of the calices, and that no distinct peripheral vesicular zone is developed as in other species of *Lonsdaleia*. The tabulate area is restricted to a quite narrow zone immediately surrounding the columella, and outside of this zone the tabulæ very soon change into a vesicular tissue; the vesicles, however, being restricted to the spaces between the septa and appearing more or less as interseptal dissepiments.

The tabulæ very distinctly cross the narrow tabulate area, but find their chief development only within the space of the columella where they form somewhat irregular conical elevations (Pl. C, fig. 4), but also in this region they are somewhat vesicular.

The columella is limited off on all sides by something like a regular wall, formed by the vertically ascending tabulæ. In the interior the columella shows many radiating plates, which either start from an imaginary central axis, or from a median transverse lamella. The latter is chiefly the case when the columella appears laterally compressed. Between these radiating lamellæ many dissepiments exist, which very probably have to be brought into connection with the tabulæ.

Locality and geological position.—This species is, excepting *Lonsd. indica*, the most common species of corals occurring in the middle Productus-limestone, and forming there the coral reefs. It has been found in this geological position at Virgal (2 specimens), at Vurcha (1 specimen), at Musakheyl, and trans-Indus by Mr. Wynne at Omarkheyl (1 specimen). In Dr. Verchere's collection there was a specimen marked "Rotta Roh," and another "Punjab."

Remarks.—The present species in its general appearance has a certain resemblance to *Lonsd. floriformis*, Flem., from the mountain-limestone of Europe; but on a closer examination one finds that the relation to Fleming's species is only a very distant one. *Lonsdaleia floriformis* has been examined and figured already many times, and in all cases it has been found that there exists a distinct zone of vesicular tissue in the peripheral parts of the corallites, that a distinct secondary wall is present, and that there is marked off by the latter a distinct and rather large tabulate area. Of all this there is nothing to be observed in our *Lonsdaleia salinaria*. Thus there cannot be any doubt that our species is different from *Lonsd. floriformis*; it belongs even to a quite different group of forms.

The group of forms to which *Lonsd. floriformis* belongs is rather plentifully represented in the mountain-limestone, chiefly by this species itself. In the upper carboniferous beds of Russia (Miatchkowa) *Lonsd. floriformis* seems to be replaced by another but very nearly related species, which belongs to the same group, and might best be quoted under the name of *Lonsd. papillata*, Fischer sp. This species has been well figured by Trautschold, and can be distinguished from *Lonsd. floriformis* proper by the circumstance that the septa very distinctly extend outside of the accessory wall to the outer wall of the corallite, no vesicular peripheral zone being developed. In this respect it approaches more closely to our *Lonsd. salinaria* than does *Lonsd. floriformis*, but otherwise it is quite as distinct.

Of the group of forms on the contrary to which our *Lonsd. salinaria* belongs, not a trace has been detected up to the present, so far as we are aware of, in truly carboniferous strata, and thus this group seems to be restricted to permian beds; it has however not yet been found elsewhere than in the Salt-range.

2. LONSDALEIA WYNNEI, Waagen and Wentzel, n. sp., Pl. XCIX, fig. 2, Pl. C, figs. 5, 6.

Corallum astræiform, composing large irregular masses. Corallites prismatic, five to seven-sided, with very thick compact walls. Calices large, generally of a diameter of 11 to 16mm., irregularly infundibuliform with a flattened peripheral and a deeply sunk median part. Walls dividing the calices strongly projecting. Columella thick, generally twisted, not much projecting. The calices do not, generally, present the appearance as if there were a secondary wall. Septa mostly very much thickened by a secondary deposition of stereoplasma. There are generally 20 to 24 primary septa, which are the longest, and as many secondary ones, which are shorter; between these a number of short septa of lower orders are intercalated.

In thin sections it can be distinctly seen that all the septa reach the outer wall of the corallites and are not lost in a peripheral vesicular zone. Vesicles are present in great numbers, but they all appear as interseptal dissepiments. There is not a trace of a distinct accessory wall. The tabulate area is very small and restricted to the space between the termination of the primary septa and the columella. None of the septa reach down to the columella but all stop short of it. The primary septa terminate with a blunt somewhat thickened end. The columella is thick and cylindrical, not compressed as in the preceding species; its structure is tolerably regular; there are many radiating lamellæ, somewhat variable, mostly twisted, as can often be well observed in thin sections. In longitudinal sections a great number of tabulæ appear; they are chiefly distinct within the columella and in the zone that intervenes between it and the termination of the primary septa. Outside of this they are soon lost between the numerous vesicles that fill the spaces between the septa. Within the columella they form flat upright cones, in the tabulate area they are horizontal, and outside of it they quickly ascend, forming many vesicles. The structure of the vesicles is often singularly folded.

Locality and geological position.—The present species is considerably scarcer than the preceding one. It is, however, also restricted to the middle division of the Productus-limestone. It has been found up to the present only at a single locality, at Katta, where two specimens were collected.

Remarks.—The present form is on the whole very nearly related to the preceding one. It differs however from *Lonsd. salinaria* by its considerably larger calices, by which character, even without thin sections, the two species may readily be distinguished. According to the thin sections we have prepared it appears that in the more intimate structure *Lonsd. wynnei* deviates from *Lonsd. salinaria* by the mostly round form and twisted condition of the columella, and by the less vesicular development of its tabulæ.

For the distinction of *Lonsd. wynnei* from *Lonsd. floriformis* and its allies the same characters can be adduced that have been quoted already as distinctive between *Lonsd. floriformis* and *Lonsd. salinaria.*

Aberrant species.

3. Lonsdaleia indica, Waagen and Wentzel, n. sp., Pl. CI, figs. 1—3., Pl. CXV, figs. 3, 4.

Corallum compound, composed of columnar, more or less cylindrical, tolerably straight, perfectly free corallites, united together only at the places where one takes its origin from the other by gemmation. Corallites only in very rare cases very nearly approached or nearly blended together. Calices small, never more than 6 to 8mm. in diameter, regularly infundibuliform, never showing the appearance as if a secondary wall was present, never very deep. Columella very thick, occupying not quite one-third of the diameter of the entire calix, never twisted, rather strongly prominent, so compact that it sometimes weathers out and is found separately. Septa not numerous; there are about 20 primary and as many secondary septa, all uniting at the periphery to form a distinct outer wall, which shows a longitudinal striation (Pl. CI, fig. 2).

In thin sections one sees that the primary septa only partly stop short of the columella, whilst another part of them reaches it well, and unite even with the radiating lamellæ within the columella. Between the septa a great number of interseptal dissepiments are present, which, though they often occupy more or less a central area, yet never unite to form a distinct accessory wall. In transverse sections the columella is very distinctly marked off by a proper wall. In the middle it shows a central transverse lamella, from which smaller ones radiate in all directions. These are again interrupted by some concentric lamellæ. In longitudinal sections one sees that the outer wall of the columella is made up of vertically ascending tabulæ, which slowly bend towards the centre and form blunt cones, one in the other. These are traversed by vertically ascending lamellæ which correspond to the transverse and radiating lamellæ of the transverse sections. It is remarkable that in longitudinal sections there can barely any tabulæ be observed outside of the columella, unless the steeply ascending lines in fig. 3*c*, Pl. CI, on both sides of the columella should be considered not as irregularly cut septa but as tabulæ. In any case the arrangement of the tabulæ is exceptional; and on this ground it might even be proposed to distinguish the present form as a proper genus. Just along the outer wall of the corallites there is a thin, irregular zone of vesicles.

Locality and geological position.—This is one of the commonest species of corals in the Salt-range. It finds its chief development in the coral-beds of the middle Productus-limestone, but extends also, though more rarely, into the upper division. Specimens of it have been collected in the middle division east of Katwáhi (1 specimen), in the Chittawán (1 specimen and many fragments), at Vurcha (1 specimen), at Chidru (1 specimen), on the road from Chidru to Musakheyl (4 specimens), at Virgal (many fragments), and above Nursingpohár (1 specimen). Trans-Indus it was found by Mr. Wynne at Kiri (1 specimen), and there is also a specimen from Dr. Verchere's collection marked "Punjab."

In the upper Productus-limestone the species occurred in the mountains east of Katwáhi, in the section at Khura (only fragments), and trans-Indus at Bilot (1 specimen).

Remarks.—The present species so far deviates from all the others of the genus *Lonsdaleia* that a more detailed comparison with any of them seems unnecessary. The transverse lamella which forms the centre of the columella recalls to a certain extent the genus *Lithostrotion*, but the whole structure of the entire very thick columella so very nearly agrees with that of *Lonsdaleia salinaria*, that if we do not prefer to consider this form as a proper genus, we must place it in the genus *Lonsdaleia*.

The preservation of some specimens of the present species is singularly good, and some of the thin sections we have prepared allow of the application of very high magnifying powers. In consequence of this the structure of the septa can be very well studied, a circumstance which is of some interest with regard to certain observations made by Koch and von Heider. In Pl. CI, fig. 3*b*, we have given the representation of part of a section, very strongly magnified, which shows two important points, first, that the septa are not equal in structure throughout, and second, that the outer wall of the corallites is no proper organ by itself but is formed only by the lateral joining of the septa.

The septa are distinctly composed of two parts, a central one, which is of a dark colour, and a peripheral or coating one, which is light-coloured and finely fibrous. The dark-coloured part, which can, however, when differently preserved, appear as a distinct white line, represents what has been called by Koch the "primordial stripe" or primordial septum. According to Frech's observations it would appear not improbable that this primordial septum itself is again produced by the blending together of a number of septal spines. This bears on its surface secondary thickenings which are of a different structure. The primordial septa extend to the outer side of the corallites, here slightly projecting and causing thus the longitudinal striation which is exhibited on the outer surface of these corals. The secondary thickening fills the spaces between the primordial septa in the peripheral parts of the corallites, thus completing the outer wall. Now in this outer wall, in the spaces between the primordial septa, fine dark lines have been observed by Koch, which he thought were the traces left behind by the sarcosepta, which thus were encased and fixed by the sclerosepta. Heider, however, opposes Koch's views and declares these dark lines to be cracks produced by the process of grinding down the specimens. That this latter view is the right one is shown by our drawing, where the wall is quite complete and no such dark line is observable within the wall between the primordial septa. With this, moreover, Koch's views as to the growth of the corals are refuted, and Heider's opinion, that the animals regularly ascend in their tubes in the same degree as they deposit calcareous matter behind them, appears well founded. Numerous observations, tending to the same purpose, have recently been published by Dr. Frech, in the Zeitschr. d. Deutsch. Geolog. Ges. 1885, p. 928.

Another point which requires some consideration in this form is the mode of propagation, which is a rather singular one and has been figured by us Pl. CXV, figs. 3-4. Already, however, by Thomson and Nicholson, very exact figures of the process of gemmation in a similar form (*Lonsdaleia rugosa*, McCoy) have been given, and they are very well in accordance with what we have seen in the Indian specimens. The new corallite, as has been already observed by the above-mentioned authors, takes its origin in the vesicular tissue forming, in most species of *Lonsdaleia*, a peripheral zone in each corallite. The daughter animal deviates, however, in its direction more or less strongly from the mother animal. In *Lonsdaleia rugosa* the two form together an acute angle, whilst in the Indian form the young one proceeds at right angles from the side of the mother animal. At first the young animal is simply cup-shaped, and possesses as gifts from its mother nothing but the outer walls and a little vesicular tissue, the septa being still quite rudimentary. Later on the septa become well developed, mostly only after the young individual has again bent at right angles to its former direction, now ascending vertically. In this state the primary and secondary septa are not yet very much different in length, but the bilateral structure of the rugose corals is developed very distinctly, a kind of septal fossula being present, indicated by two septa which very strongly diverge, whilst opposite there is an exceptionally strongly developed septum. Somewhat later the columella is developed. Its first state could not be observed by us; we find it in our figure already in a perfect state, with its radiating lines and dissepiments. Our fig. 3 on Pl. CXV, represents such young corallites in different stages of development, some of them still quite without a columella, another with a columella but otherwise not yet fully developed, all of these being badly deformed by want of space, being crowded together between some old full-grown individuals.

The gemmation itself, which is thus exhibited by these compound forms of *Lonsdaleia*, cannot exactly be classed under any of the schemes pointed out by Koch in his work on the gemmation of corals, and referred to above, page 858. Nevertheless it seems to us to be most nearly related to the mode of gemmation that occurs in the astræiform species of the genus, and which is absolutely identical with what has been called by Koch a "tabular gemmation." It has been stated above that the young individuals take their origin in the vesicular zone that is developed in the peripheral part of most species of *Lonsdaleia*. Now these vesicles, wherefrom the gems take their origin, can well, we think, be considered as singularly transformed tabulæ, and thus the gemmation may be termed a vesicular one, but as a modification only of Koch's tabular gemmation.

4. LONSDALEIA VIRGALENSIS, Waagen and Wentzel, n. sp., Pl. CI, fig. 4, Pl. CXVI. fig. 2.

Corallum compound, composed of very thin, more or less cylindrical, tolerably straight corallites, rather far apart from each other, with numerous transverse wrinkles and folds and bearing a fine longitudinal striation. Calices very small, never more than 4mm. in diameter, with traces of a secondary wall. Columella very thick, even thicker than in the preceding species, occupying a little more than one-third of the entire diameter of the calices. Septa very little numerous. There are 18 to 20 primary septa and as many secondary ones; septa of a third order are never developed.

In thin sections one can observe that the primary septa generally do not reach the columella, though they approach it very nearly; only in some calices one or the other of these septa seems to touch the outer circumference of the columella, but never in contact with one of the radiating lamellæ within the latter. Between the septa there is a great number of interseptal dissepiments, which very often for a part are regularly arranged, so that a partial secondary wall is formed; this secondary wall is, however, barely ever complete, but exists generally only in a more or less extended part of the calices. Nevertheless it has some influence on the development of the tabulæ, so that sometimes a tabulate area can be pretty clearly distinguished. The columella is very sharply circumscribed. It shows in the middle a transverse and towards its periphery some radiating lamellæ which are crossed by a concentric lamellation, a structure which is absolutely identical with that of the preceding species. In the longitudinal sections the existence of a more distinct tabulate area causes some difference from similar sections of the preceding species but otherwise both show the same features.

Locality and geological position.—There are only two specimens of this species in the Salt-range collection, which were both found in the coral-beds of the middle division of the Productus-limestone of Virgal.

Remarks.—We were a long time in doubt whether we ought to separate the present species from the preceding one, but after some consideration we found that the two specimens from Virgal were distinct from all the others not only by the considerably thinner branches, but also by some internal characters. A comparison of fig. 1*c* and fig. 4 on Pl. CI, will show these differences readily. Whilst in *Lonsd. indica* the interseptal dissepiments are arranged quite irregularly, they follow a more or less circular arrangement in the present species, so that very often a kind of secondary wall is formed. With this also a somewhat different arrangement of the tabulæ goes hand in hand, and thus we think the two species should be kept separate. The most striking difference consists always in the thinness of the branches, which never exceed 4mm.

Sub-Family: *DIAPHRAGMATOPHORA.*

Genus: AMPLEXUS, Sow.

Among the materials of corals from the Salt-range there are also a few specimens of single corals, which present nearly insurmountable difficulties in the attempt to arrive at a satisfactory determination of them.

The scarcity of specimens forbids the free use of the grindstone, and besides this, the preservation of the specimens is for the greater part so spathic that polished sections are of but little use; the description must then be brief and to a certain extent incomplete. Yet we thought it not fit to pass them over in silence, as the proposed outlines of the entire fauna of these beds would no longer be correct if such a large division of corals, specimens of which are not unfrequently met with, were not mentioned at all; thus we shall give a description of these forms as best possible according to the materials at hand.

As far as can be made out it seems that all the single corals that are preserved in the Salt-range collection belong to the genus *Amplexus*, as they possess more or less closely set tabulæ, very short septa, and a small but distinct septal fossula. A vesicular zone in the peripheral parts of the individuals is absent, but they all are covered with a distinct thick epitheca.

Two forms can be made out which are also distributed in different geological horizons. One of them is restricted to the middle division of the Productus-limestone and seems to us to be a new species to which the name of ***Amplexus cristatus*** will be given; the other species occurs only in the upper Productus-limestone, and seems to us identical with what has been described by Abich under the name of ***Amplexus coralloides***, Sow., from the permian beds of Djoulfa, and which has been shown by Möller to be different from Sowerby's species, without, however, giving a name to it. It seems to us that this form most practically would receive the name of ***Amplexus abichi***.

1. AMPLEXUS CRISTATUS, Waagen and Wentzel, n. sp. Pl. C, fig. 2.

Corallum simple, elongately conical, generally curved, fixed by its apex to foreign bodies. Surface longitudinally striated, undulating, provided at intervals with high transverse crests, on which thorn-like processes are placed. The crests do not show any regularity and never encircle the entire coral. Calix apparently deep but much worn and deteriorated by pressure, provided with very short septa. Septa not numerous, altogether, primary and secondary, not more than 28. In sections the length of the septa is about one-third of the entire diameter of the corallum. Septal fossula distinct, deep, not large, being enclosed by two longer septa and containing only one single septum. Septa connected together by septal dissepiments not far from their terminations. Space between the dissepiments and the outer wall filled by rock-matter without intercalation of a vesicular tissue. Tabulæ not very numerous, very strongly convex, flattened on the top, the tabulate area occupying the entire space of the corrallum.

The dimensions of the better preserved of the two specimens at our disposal are as follow:

Length of the entire corallum	42 mm.
Thickness at the upper extremity	19 mm.

Locality and geological position.—There are altogether not more than two specimens of this species in the Salt-range collection. One of them comes from Káfirkot, from the middle division of the Productus-limestone, the other from between Vurcha and Ucháli out of the same beds.

Remarks.—The species which is most nearly related to the present one, and which perhaps would be considered by some even identical, is ***Amplexus spinosus***, Kon., from the mountain-limestone of Tournay, etc. This interesting and well-characterised species agrees with the Indian form in having the same number of septa, which are of the same length, and in its possessing thorns on the lower part of its outer surface. The difference of the two forms consists in the high thorned crests in the Indian form, and apparently also in a much deeper visceral chamber and more strongly convex tabulæ.

At all events, ***Amplexus spinosus*** must very probably be considered as the ancestor of ***Amplexus cristatus***, which represents the former species in more recent strata.

Of other species none is known to us which could be more particularly compared.

2. AMPLEXUS ABICHI, Waagen and Wentzel, n. sp.

1878. *Amplexus coralloides*, (Sow.) Abich: Fauna of Djoulfa, p. 84, pl. XI. fig. 10 (*non* Sow.).
1879. *Amplexus sp.*, Möller: Neu. Jahrb., 1879, p. 237.

There are two specimens of a not very large, rather smooth *Amplexus* in the Salt-range collection, which probably can be identified with ***Amplexus coralloides***, Abich (*non* Sow.). The specimens are, however, in much less satisfactory preservation than those figured and described by Abich, and thus we have abstained from giving a figure of them. The diagnosis of the species may run as follows:

Corallum simple, elongately conical or sub-cylindrical, straight or slightly curved with a tolerably thick epitheca on its outer surface, which is longitudinally striated and shows many wrinkles of growth encircling the whole corallum. Calix apparently not very deep, with few not very strongly developed septa. Septal fossula small, and not very distinct. Septa numbering 26 to 28 at a diameter of the calix of 18mm. Length of the septa little more than one-fourth of the diameter of the calix. The septa are united towards their termination by a row of septal dissepiments. Tabulæ numerous, vaulted, largely flattened on the top, often irregular and somewhat vesicular.

The species did not apparently attain very considerable dimensions. The largest specimen figured by Abich has a diameter of 23mm. at its upper extremity and may have reached a length of about 75mm. Our Indian specimens are by far smaller, attaining a diameter of 16 and 18mm. at the upper extremity.

Locality and geological position.—Both specimens of this species in the Salt-range collection come from the upper division of the Productus-limestone; one of them was found in the Cephalopoda-bed at Jabi, the other at the limit between the upper and middle divisions at Khura.

Remarks,—There cannot be any doubt that the case has been put too strongly by Mr. Möller, when he says: These forms have not the slightest similarity with ***Amplexus coralloides***, Sow. If this were in reality the case, we should not know to what form else the present species should be compared. In reality we think the species so closely related to ***Amplexus coralloides***, that a separation becomes rather difficult, and the mistake of having it described as identical with Sowerby's species cannot be considered as very great.

The chief differences consist in the septa being slightly longer and somewhat less numerous than in equal-sized specimens of ***Amplexus coralloides***, so that the present species can well be considered as different, but must at the same time probably be taken as a direct descendant from the lower-carboniferous species.

We know of no other form with which ***amplexus abichi*** could be more particularly compared.

The identity of our Indian specimens with this Armenian permian species is again of some geological interest.

Order: ALCYONARIA.

Sub-Order: HELIOPORACEA.

Family: *FISTULIPORIDÆ.*

The *Alcyonaria* have an entirely stony skeleton, not internal but covering the body to a certain extent externally; they can be divided in two groups. One of these is formed by *Tubipora* and the allied genera, which all have a stolonal gemmation; the other is typified by the genus *Heliopora*, and in this group a cœnenchymal gemmation prevails. The number of genera which, by this character, appear rather nearly related to *Heliopora*, is pretty large; two groups can be distinguished among them. The first has rather large polypites, having a more or less large number of pseudosepta; to this group the genera *Heliopora*, *Heliolites*, &c., belong; the second group has only small tabular polypites either entirely without pseudosepta or with only two of them, which is the highest number that ever occurs.

The first of these groups forms the family *Helioporidæ* of Mosley, the second the family *Fistuliporidæ*.

Thus to bring to notice the rather near relation between the two families we have created a sub-order, *Helioporacea*, for their reception.

The family *Helioporidæ* has been excellently characterized by Mosley; and Zittel has in his Handbook quoted the different genera that probably can be considered as belonging to it. Nicholson also has contributed much towards the elucidation of the family.

The case is different with the family *Fistuliporidæ*. First of all it has not been recognised to constitute a family up to the present; on the contrary, the genus *Fistulipora* was either considered to form part of the *Monticuliporidæ*, or else it was entirely removed to the *Bryozoa* and considered as only a stage of development of certain Bryozoan genera.

When we took up our studies on the *Monticuliporidæ* we had naturally to include *Fistulipora* and allied genera, as Nicholson had treated them all together, and it was from the beginning by no means evident that *Fistulipora* was so radically different from *Monticulipora* as we now must consider it to be. As the case stood we had to a certain extent to notice the characters of the *Fistuliporidæ* in the introduction to the *Monticuliporidæ*, and we there stated that the most fundamental difference between them consists in the mode of gemmation, which is in the latter an intermural one; whilst it is cœnenchymal in the former.

It has been shown by Koch and others, that cœnenchymal gemmation is characteristic of *Heliopora*, *Heliolites*, and other *Alcyonaria*, and that it does not occur in any of the *Hexacoralla* or *Rugosa*.

To get at a right understanding of the process of cœnenchymal gemmation, we must take a look at the cœnenchyma with which all these forms are provided and from which gemmation takes its origin.

It must first be remarked that the cœnenchyma in the *Helioporacea* is an organ entirely different from anything that occurs in other corals. Originally it consists entirely of parallel tubes, which are again parallel to the polypites, and every cœnenchymal tube possesses numerous tabulæ. This tubulate condition of the cœnenchymal cells, so that each of them can be followed for greater distances, and appears perfectly individualized, distinguishes the cœnenchyma of the *Helioporacea* from that occurring in other corals, as in the latter the cœnenchyma is always of a spongy nature and never composed of straight tubes, or of vesicles which have even originated in such tubes. If, as is often the case in the later stages of growth, the tubes are resolved into irregularly arranged vesicles, the tubes can no longer be followed. This is caused by an excessive growth of the tabulæ, as has been already stated by Nicholson. In such cases it must always be borne in mind that only the last layer of vesicles was occupied by living animals. The excellent explanation given by Lindström of the formation of cœnenchyma can apply only to the cœnenchyma of the *Zoantharia* but not to that of the *Alcyonaria*.

With regard to these cœnenchymal tubes the opinion has been expressed by Mosley that they were the dwellings of singularly transformed animals, so that a colony of *Heliopora* (the living form on which Mosley made his observations) was to be considered as dimorphic, as composed of two different sets of animals, of which the one, the *siphonozooids*, dwelt in the cœnenchymal tubes, whilst the others, the *autozooids*, occupied the larger calices. Leukart also is inclined, induced by the observations made on *Sarcophyton*, to concur with Mosley in this view, though the siphonozooids in *Heliopora* have neither stomach nor mesenteries, and do not even open on the surface.

Now with regard to the existence of such reduced animals the cœnenchymal gemmation opens out a very strange perspective.

In the cœnenchymal gemmation a number of these cœnenchymal tubes apparently unite to form together a new autozooid, so that several reduced individuals become blended together into a single perfect one.

The process can be very distinctly followed in recent and fossil forms and has been figured exactly by Koch (Palæontograph. 3 Ser. Vol. V.) in *Heliopora* and *Heliolites*, by Lindström in *Plasmopora*, &c. Also we have given figures representing the process Pl. CXV, figs. 5 and 6. In this process a group of cœnenchymal tubes becomes more distinctly circumscribed, slowly it affects a circular or, as the case may be, a bilobed appearance, then the walls of the single tubes, lying within the circumscribed area, become dissolved by degrees and at last the new autozooid has attained its full development.

In longitudinal sections one sees several cœnenchymal tubes with their closely set tabulæ ascending straightly, then they suddenly stop, and in their place a large tube possessing less numerous tabulæ appears.

This cœnenchymal gemmation has been studied already so often and by so many observers that there cannot be any doubt about the process itself, and the difficulty exists only with the explanation of it.

The reasons why the cœnenchymal tubes are considered to be inhabited by a distinct sort of animal are two, first, the tabulate condition of these tubes, and then their mode of augmentation. As regards the first character, it has been stated by Mosley that in *Heliopora* only the uppermost part of the colony is actually alive, and that all below the last tabula is dead, and often inhabited by parasitic animals. Now the cœnenchymal tubes develop their tabulæ independently of the large tubes, and thus it appears not improbable that they are also inhabited by independent animals. As regards the augmentation of the cœnenchymal tubes, this really appears as a kind of propagation, as occurs in fully developed corals. Generally the tubes augment by fissiparity, as has been shown and figured by Koch and recently by Nicholson and Foord; but by Mosley there has been described in *Heliopora* a mode of augmentation which comes very near "intermural gemmation." Quenstedt, however, long ago made observations in this direction; he says that the new cœnenchymal tubes appear quite in the same way as do the new corallites in *Chætetes*, and fragments could even be mistaken for each other. That intermural gemmation occurs off and on also in the cœnenchyma of fossil forms is shown by *Fistulipora eriensis*, Roming, whereby, in the corners where several cœnenchymal tubes meet, spiniforms corallites, or Acanthopores as they are now called by Nicholson, are developed, a nearly unmistakable sign of intermural gemmation. These two characters combined make it appear highly probable that the cœnenchymal tubes are really inhabited of by proper animals, which display certain functions, as the production of tabulæ and gems.

Great donbts have, however, been brought forward against Mr. Mosley's view by Lindström, the chief of which is that several of these tubes blend together to form one fully developed animal, a process which does not occur besides in the whole animal world. Though this is a point that ought to be properly worked out by zoologists, we may perhaps suggest some view which might dispense with this most extraordinary fact.

Mr. Koch has, in the *Pennatulidæ*, observed the fact that sometimes one of the *siphonozooids* is transformed into an *autozooid*. Now with this transformation a great change in size certainly goes hand in hand, and the new *autozooid* requires much more room than formerly did the *siphonozooid*. It might then well be imagined, that in reality only one of the *siphonozooids* inhabiting the cœnenchymal tubes is transformed into an *autozooid*, but to make room for the new individual thus formed, the surrounding *siphonozooids* die, and that the first sign of this beginning decay is just the thickening of the outer walls, which are destined to form together the wall of the new *autozooid*.

An observation which is also in favour of the view that the cœnenchymal tubes were inhabited by proper animals has been recorded by Dybowsky; this is that the whole colonies are in their beginning often composed of nothing but cœnenchymal cells, and only later on the larger tubes are developed. We could ourselves very often observe the same fact; and even the description of the very youngest individuals of *Heliolites* given by Linström says: Die jüngsten Individuen einer Helioliten-

Colonie, oder vielmehr der erste Polyp, der Gründer einer solchen Colonie, hat ein dütenförmiges, spitzes Polyparium. Die kleinsten, welche ich gefunden, messen 1mm. Man sieht doch schon die zwölf Septen, und *auf der Bodenseite des Polypariums breitet sich ein feinmaschiges Cœnenchyma aus.* (Richthofen's China Vol. IV p. 59.)

After having thus considered the cœnenchymal gemmation in general, we must turn again to the ***Fistuliporidæ*** in particular. That ***Fistulipora*** has a cœnenchymal gemmation is amply shown by Nicholson's figures of the typical species, ***Fist. minor***, M'Coy, or, as it must now be called, ***Fist. incrustans***, Phill., and by Dybowsky's figures of ***Callopora***; and that this gemmation is absolutely identical with what has been described and figured of ***Heliopora*** and ***Heliolites*** is so obvious, that it needs only a look at the drawings to become convinced of the matter.

The genus ***Fistulipora*** only occurs sparingly in the palæozoic beds of the Salt-range, and we must rely chiefly on other genera for the particulars of the family. These genera are, however, on the whole so nearly related to ***Fistulipora*** proper, that what applies to them will be applicable also to ***Fistulipora***.

The two genera we have to describe are ***Dybowskiella***, a new genus, which will be described presently, and ***Hexagonella***, also a new genus allied to ***Evactinopora***, Meek and Worthen. In these genera the cœnenchymal gemmation has been followed by us in detail, and it could be observed not only in longitudinal sections, where several cœnenchymal tubes are suddenly replaced by a large tube, but also in transverse sections, where the blending together of the cœnenchymal tubes to form a new polypite could be followed step by step (Pl. CXV, figs. 5, 6), that the process is absolutely as in ***Heliolites*** or ***Plasmopora***, and that the difference between those genera and the ***Fistuliporidæ*** is not a structural one, but consists only in the circumstance that the polypites are generally smaller in the ***Fistuliporidæ***, and are either altogether devoid of pseudosepta, or when the latter are present they never exceed the number of two.

The similarity between ***Fistulipora*** and ***Heliolites*** is a fact that has been long since recognised, and it has been expressed very clearly by Nicholson. It often goes so far that one has been mistaken for the other, and species of ***Heliolites*** have been described as ***Fistuliporæ*** and ***vice versa***. Notwithstanding this, Lindström considered the similarity as only external, and places the larger part of ***Fistuliporæ*** in the ***Bryozoa***, thus separating them entirely from the corals. We are not prepared to assert that in every case what has been described under the name of ***Fistulipora*** is really a coral; but for those forms that show the cœnenchymal gemmation described above we must absolutely claim the coral nature, as this is a character so intimately connected with the nature of certain forms of corals, that a fossil which bears this character cannot possibly be anything but a coral. Thus Lindström's view can apply only to forms which have a quite different gemmation, that is to say, the gemmation that occurs in the ***Bryozoa*** as has been described above in the introduction to the ***Monticuliporidæ***. That such forms really exist cannot be denied; but ***Fistulipora incrustans***, Phill., the very type-species of the genus, does not belong to them, so we cannot but place the genus among the corals, and not among the ***Bryozoa***.

Nicholson places rather great stress on the circumstance that there are no distinct pseudo septa in ***Fistulipora***, and considers this as sufficient reason to separate the genus from the ***Helioporidæ***, with which it is confessedly very nearly related, placing it in the ***Monticuliporidæ***. Though we also think that the presence or absence of pseudosepta can well be used as a character for the distinction of families, yet we must separate the ***Fistuliporidæ*** from the ***Monticuliporidæ*** on account of the different gemmation that prevails in the two families. The ***Fistuliporidæ*** must be placed in the vicinity of the ***Helioporidæ***, as showing the same mode of gemmation, and the ***Monticuliporidæ*** in the vicinity of the ***Favositidæ*** as agreeing in their mode of gemmation with the latter.

After having thus discussed in detail the systematic position we give to the ***Fistuliporidæ*** we may safely proceed in exposing the characters of the family.

The skeleton consists of a hard calcareous mass, which does not show any sign of being composed of sklerites. The several parts of it are arranged so as to form distinct walls by which larger round or oval polypites and smaller cœnenchymal cells are circumscribed. These walls show in transverse sections, as in other corals, a dark line in the middle indicating the existence of a primordial wall. In silicified specimens the dark line is replaced by a light-coloured one. Quenstedt has observed the same dark line in the middle of the walls of species of ***Heliolites***, and concludes from this observation that the walls in ***Heliolites*** were double. On both sides of this primordial mural plate secondary thickenings of the walls are observable, but in most forms of the family these thickenings remain always very thin, only rarely they attain a certain thickness and then are distinctly seen to be composed of calcareous fibres, vertical to the surface. Such thickenings are often restricted to one side of the tubes of the polypites only.

There are two kinds of cells: the larger ones, the true polypites (which, however, never attain considerable dimensions, 2mm. being about the largest diameter they ever exhibit) show a round or oval, sometimes a bilobed, outline and only rarely contain a trace of two pseudosepta, never more, whilst generally septa are entirely absent; and the smaller cells, occupying the space between the larger ones; they are angular and form a distinct cœnenchyma, being sometimes present in great numbers.

There is no direct communication between the larger and the smaller cells, though in some forms of ***Dybowskiella***, when they are not very well preserved, the mistake might arise that such a communication existed.

Sometimes the cells of the cœnenchyma appear somewhat incomplete, not being perfectly circumscribed on all sides. This is probably a feature that depends upon preservation solely, and is of no palæontological importance.

In longitudinal sections the cells of the larger polypites are tubular and show distant, mostly complete, tabulæ, to which sometimes a vesicular tissue is added. Also the cœnenchymal cells are mostly tubular, with a great many tabulæ, which are very closely set and sometimes strongly vaulted. Often the tabulæ are developed to such an excessive extent, that the walls of the tubes are quite obliterated, and each chamber, partitioned off by a tabula, is transformed into a vesicle.

All the forms belonging to this family have a cœnenchymal gemmation.

The number of genera that can be placed in the present family is not very great, nevertheless some sub-families can be distinguished very conveniently.

I. Sub-family: *CALLOPORINÆ.*

The polypites are small, tubular, with simple tabulæ, devoid of pseudosepta and of so-called folds as described by Nicholson and Foord.

1. Callopora, Hall, 1852: Pal. of New York, vol. II, p. 144; Dybowski: Die Chætet. des ostbalt. Silur, p. 106, 1877.—At the beginning we considered this genus identical with *Fistulipora*, McCoy, following in this respect Nicholson's own indications. But since that author has changed his views as to *Fistulipora*, this latter genus cannot be considered any longer as identical with *Callopora*. We must take as correct the observations made by Dybowsky, who has proved in every case a very fair observer, and must accept the view that the silurian species described by him were without "folds." Whether Dybowski's identification of his silurian forms with *Callopora*, Hall, was correct, is another question, which cannot be solved for the moment. We therefore have quoted also Dybowski's work. Colonies arborescent or incrusting. Silurian.

2. ? Evactinopora, Meek and Worthen, 1868: Geological Survey of Illinois vol. III, p. 501.—Colonies bilateral, with polypites rising from a median calcareous lamella, forming lamellar expansions which are arranged regularly around an imaginary axis, thus assuming star-like figures. Carboniferous: ? Permian.

3. Hexagonella, Waagen and Wentzel, n. gen.—Like *Evactinopora*, but the lamellar expansions never regularly arranged, often forming flattened branches; on the surface the polypites distributed in generally hexagonal spaces, which are divided from each other by more or less high ridges and bear mostly maculæ in the middle.

II. Sub-Family: *PRASOPORINÆ.*

Polypites small, tubular, with tabulæ partly transformed into a kind of vesicular tissue, or single vesicles along the walls of the polypites. No pseudosepta developed.

4. Prasopora, Nich. and Eth. jun., 1877: Ann. and Mag. Nat. Hist., ser. IV, vol. XX, p. 388.—Corallum concavo-convex or discoid, sometimes free with a concentrically striated basal epitheca, more rarely attached by its base to some foreign object. Silurian.

III. Sub-Family: *FISTULIPORINÆ.*

Polypites small, tubular, with simple tabulæ, provided with a thickening or callosity on one side of the tube, which at both ends is sometimes developed into two distinct pseudosepta, whereby the tubes get a bilobed appearance in transverse sections.

5. Fistulipora, McCoy (emend. Nicholson and Foord), 1852: Ann. and Mag. Nat. Hist., ser. 2, vol. III, p. 130; 1885, Nicholson and Foord: Ann. and Mag. Nat.

Hist., ser. V, vol. 16, p. 496.—Polypites with a little prominent callosity on one side of the tube, forming the "folds" described by Nicholson and Foord. Colonies incrusting, rarely arborescent. Silurian to carboniferous.

6. **Dybowskiella**, Waagen and Wentzel, n. gen.—Polypites with two strongly developed pseudosepta projecting into the interior of the tube. Colonies arborescent, polypites never arranged bilaterally on a median plane, sometimes incrusting. Devonian to permian.

With these genera the number that we can with safety assign to the family is ended. A number of other genera have, however, been described and studied in detail by Nicholson and Dybowsky, which could find no place in the list, as we are by no means certain as to their systematic position. In all these the cœnenchymal gemmation, the only safe criterion for the discernment of the systematic position of these little things, could not be made out from existing drawings, and we had neither time nor materials to make studies in that direction. Nevertheless there are in many cases some characters observable which make a position among the corals very doubtful, and rather suggest the thought that they should be considered as *Bryozoa*. Such forms are *Trematopora*, Hall, as described by Dybowsky, and *Dittopora*, Dybowsky. In these forms the "Wandröhrchen," as they are called by Dybowsky, can well be compared with the "interstitial ribs" as described by Smith in *Discoporella*, &c. But also in other respects these colonies are more like *Bryozoa* than like corals. In the young state, that is, in the central parts of the colonies, there is no cœnenchyma present; this is developed only later on, or is entirely replaced by a compact ground-substance. This shows that in these forms the cœnenchyma is not morphologically the same thing as in *Fistulipora* for instance, and that it is probably to be considered identical with the interstitial substance of the *Bryozoa* that often fills the spaces between the single animals, and appears only in old colonies, when the single animals follow different directions. In *Dittopora* again there is sometimes the appearance as if two different sets of animals were present, distributed in different zones. This appearance, however, seems to be brought about only by the circumstance, that in some of these zones the animals are more closely packed together than in others, and therefore they appear angular and without any interstitial substance.

The same reasons cause us also to consider *Stellipora*, Hall, or *Constellaria*, Dana, as a Bryozoan rather than as a coral; their tubes are united in little groups, in which a cœnenchyma is entirely wanting. These little groups project above a general mass of interstitial substance, which is made up of the so-called cœnenchyma. But, as has been stated above, a definite judgment on these forms can only be passed after the mode of gemmation is studied in detail.

In the Salt-range only two genera belonging to the family *Fistuliporidæ* have been detected up to the present, *Hexagonella* and *Dybowskiella*; both, however, furnish rather numerous species and a multitude of specimens. To these must yet be added one species of *Fistulipora* proper, according to the new definition of the genus given by Nicholson and Foord.

Sub-Family: *CALLOPORINÆ.*

Genus: HEXAGONELLA, Waagen and Wentzel, n. gen.

The corallum consists of laminar expansions, which sometimes are reduced to flattened dichotomous branches. Each lamina or branch is divided along its middle by a thin calcareous lamella, on both sides of which the polypites are situated. This lamella is made up of the somewhat thickened basal lamellæ of the first layer of cœnenchyma and polypites. From this lamella the polypites rise vertically (to the plane of the lamella). It cannot be exactly made out whether the first layer is not entirely made up of cœnenchymal cells; soon, however, some of these cells unite to form larger polypites. These polypites open on both surfaces of the lamellar expansions with round or oval calices, separated from each other by a space of cœnenchyma which is either equal to or double the diameter of the polypites. Larger spaces, entirely made up of cœnenchyma, form maculæ. Cœnenchymal cells always polygonal. In sections vertical to the planes of the corallum one sees that the tabulæ are often all on the same level, and thus a somewhat laminar structure of the corallum is brought about. Another cause of an apparently laminar structure is the partial silification of the specimens.

The surface of the corallum is provided with more or less prominent straight ridges, which mark off polygonal, mostly hexagonal, spaces, within which the calices of the polypites are often somewhat radially arranged. Maculæ are generally found in the middle of these spaces. These ridges are a rather superficial structure and do not reach far inside the corallum, so that they are easily rubbed off and destroyed by weathering.

We are by no means quite certain that the present genus is always a well distinguishable one; the genus *Evactinopora* of Meek and Worthen is very nearly related, and might even perhaps be partly identical. These doubts have been greatly augmented after the description by Hudleston of some species of *Evactinopora* from Australia which can partly be considered as nearly identical with the Indian forms. Nevertheless the original description of the genus *Evactinopora* is so unsatisfactory—one cannot even make out whether there exists a cœnenchyma or not, and the authors themselves have considered it as a Bryozoan—that the identification of other specimens with this American genus becomes rather problematical. It is very different with Hudleston's descriptions of the Australian specimens. The character on which the greatest stress has been laid by Meek and Worthen in the description of *Evactinopora*—the union of the laminar expansions in an imaginary axis, so that star-formed bodies are produced—is repeated in the Australian specimens, at least to a certain extent by some forms, and these might rightly be identified with *Evactinopora;* but others are ramified and do not fit well into Meek's genus; they rather should be removed to our *Hexagonella.* All of these, however, are shown by Hudleston to possess large and small tubes, of which the former are sparingly tabulated, whilst the latter show many tabulæ.

In thus quoting *Evactinopora* among the genera belonging to the *Calloporinæ* we rely chiefly on Mr. Hudleston's observations.

With regard to the network of hexagonal meshes that has been described above as being observable in the species of *Hexagonella* it is perhaps of less systematic importance. Nevertheless it is a strange fact that all the forms occurring in the Salt-range bear this character. A similar sculpture has been observed by Dybowsky in a species of *Diannulites*, and Eichwald has made a proper genus of it, "*Hexaporites*." As in this case this sculpture is the only distinguishing character; it is barely sufficient to found a genus upon.

The prominent ridges of which the meshes are formed are made up in the Indian forms by parts of the walls of the adjoining cœnenchymal tubes, which together form a straight line of calcareous substance. As this singular disposition of the walls only takes place in the superficial portions of the colony, the ridges cannot be followed far inside, and sections taken a little below the surface either show nothing of the ridges or only traces of them, Pl. CVII, fig. 3*a*, 3*b*. This is the cause why these ridges are so easily lost in weathered or otherwise deteriorated specimens.

Besides *Evactinopora* only the genus *Coscinium* can come into consideration for close comparison with the forms here under description. The species originally described under the name are most probably *Bryozoa* and not at all related to the *Fistuliporidæ*, but there has at least one species been described by Trautschold, *Coscinium sellæforme*, Trautsch., which, according to the description and the not very satisfactory drawings, is probably a *Fistuliporid* and not a *Bryozoon*. From our Indian materials it is distinguishable by a different mode of growth and the absence of an hexagonal network of prominent ridges on the surface.

The genus *Hexagonella* is represented in India by three species, one of which very nearly agrees with *Evactinop. dendroidea* of Hudleston, which in fact is also probably a *Hexagonella*. Nevertheless none of the Indian forms can be directly united with any hitherto described. Two of the species are characteristic of the middle division of the Productus-limestone, the third has its chief distribution in the middle division but extends also into the upper division.

1. HEXAGONELLA RAMOSA, Waagen & Wentzel, n. sp., Pl. CVI, figs. 3, 4; Pl. CVII.

Corallum consisting generally of flattened branches, which sometimes, however, become nearly cylindrical; the branches are repeatedly dichotomous, and thus the whole corallum becomes more or less arborescent. The centre of each branch is occupied by a broad calcareous lamella, from which the polypites diverge bilaterally. This lamella does not always retain the same direction, but is very often subject to a kind of torsion, which is followed also by the branches. Surface of the branches, when well preserved, provided with slightly projecting straight shelly ridges, forming a somewhat hexagonal network. In the spaces between the ridges the calices are situated. They are generally surrounded by a slightly projecting margin; are of a round or somewhat oval shape, and separated from each other generally by a space as broad or a little broader than their own diameter. Within the hexagonal spaces the calices are mostly arranged in somewhat irregular radial rows, which are vertical to the sides of the hexagons. In the middle of these spaces there occur more or less large maculæ, or smooth spaces, occupied solely by cœnenchyma. The spaces between the polypites are occupied by cœnenchymal cells, of which two to three rows between two polypites can be counted. The cœnenchymal cells are always polygonal and very considerably smaller than the polypites. They are often irregularly penetrated by boring animals.

In sections parallel to the axis of the branches the polypites are seen as comparatively wide tubes, provided with very scarce tabulæ. In reality, however, they are very small, so small that within the length of 1mm. three tubes with the intervening cœnenchyma can be counted. The spaces between the polypites are occupied by cœnenchymal tubes, the walls of which often show zig-zag bends. They are provided with very numerous tabulæ, many of which are often on the same level, thus causing a kind of lamination, parallel to the surface of the corallum. The cœnenchymal gemmation can in most sections be very clearly observed. How large the species may grow we cannot judge, as only fragments of branches are at our disposal. The largest fragment we have seen has a longer diameter of 28mm. and a smaller one of 13mm., a proof that the branches have attained considerable dimensions.

Locality and geological position.—The species has its chief development in the middle division of the Productus-limestone, but extends also not rarely into the upper division. In the middle division it has been found at Khura (3 sp.), between Vurcha and Ucháli (6 sp.), at Swás (3 sp.), at Morah (2 sp.), at Musakheyl (3 sp.), at Kálabágh (1 sp.) and at Bilot (1 sp.).

In the upper division it has been detected at Khura (2 sp.) and in the Cephalopoda-bed at Jabi (6 sp.) and Chidru (2 sp.).

From this list, it appears that the species is a very common one.

Remarks.—There are but very few forms with which the present species can at all be compared. The form which seems to be most nearly related to it is *Hexagonella dendroidea*, Hudleston sp., from Australia. That this species should be considered as a *Hexagonella* rather than as an *Evactinopora* has been stated already in the introduction to the genus. From the description, as well as from the excellent drawings given by Hudleston, this fact is scarcely doubtful; so there cannot be any differences of a generic nature between the form here under consideration and the Australian fossil. The specific differences even do not seem to be very great. The Australian form seems to have in general cylindrical branches, and only exceptionally do these become flattened; whilst in the Indian form just the reverse is the case. The Australian fossil is apparently also much more robust, and the calices seem to be larger, if the drawings are correct, as only two pores occur within the distance of 1mm. Last not least the hexagonal network of prominent ridges, so conspicuous in all our specimens, except in the very worst ones, is completely absent in the Australian species, though this is, according to Hudleston's indications, very well preserved.

Thus it seems that the Indian species is different from the Australian one, though both are generically identical.

Of other species there is apparently none to which the present one could be more particularly compared.

The preservation of the Indian specimens is, we regret to say, not very favourable for making microscopical sections on account of the infiltration of great masses of silica which obscure the more minute features of the tissue. We therefore were not in a position to give a better figure of a longitudinal section than that drawn, Pl. CVII, fig 3*c*.

2. HEXAGONELLA TORTUOSA, Waagen & Wentzel n. sp., Pl. CVIII, figs. 1, 3, 4, 5.

Corallum lamellar, forming large, branching expansions, which bend in all directions, dividing and anastomosing quite irregularly, but being exposed generally only in sections, and the surface nearly always covered by rock-matter. The lamellar expansions are divided along the middle line by a thin calcareous lamella from which the polypites extend bilaterally. Both surfaces covered by an irregular network of prominent angular ridges surrounding rather deeply hollowed spaces, in which the calices are situated. Maculæ occur only off and on in the middle of these spaces. In transverse fractures the ridges form prominent edges, whereby the whole body of the corallum appears as if fringed on both sides. The calices are circular or slightly oval, showing no regular distribution whatever. They are very small, and there are about 3 within the space of 1mm. They are about their own diameter distant from each other. Between them a cœnenchyma is developed which consists of fine angular meshes. In transverse, or, as one may also call them, longitudinal sections, the polypites appear as somewhat bending tubes, generally separated from each other by three rows of cœnenchymal cells. The tabulæ are straight and not very scarce in the polypites, but never closely set. In the cœnenchymal tissue the walls of the tubes generally show zig-zag bends, the tabulæ are very numerous, and the parts so tabulated off present an hexagonal outline. The augmentation of the cœnenchymal tubes by fissiparity can be very distinctly observed as well as the cœnenchymal gemmation that obtains in the augmentation of the polypites. The present species is, however, like the preceding one, not very favourably preserved for making thin sections, as it is nearly always partly silicified, which, on the one hand, impedes the preparation of good slides, and on the other interferes with the clearness of the pictures. The preparation represented on Pl. CVIII, fig. 1*c*, is, however, on the whole satisfactory.

As to the size of the species nothing can be said, as only fragments are accessible to our observation; it seems, however, that it grew to considerable dimensions.

Locality and geological position.—The present species has as yet not been detected in the Salt-range proper; all the materials of it were collected by Mr. Wynne in the trans-Indus continuation of the range. It seems to occur there in the thick coral limestones of the middle division of the Productus-limestone. The specimens which have served for description came partly from Bilot, partly from Gulámi. There are altogether four specimens.

Remarks.—There have been described, as far as we are aware, no species, with which the present one could be compared more in particular. From *Hexagonella ramosa*, described above, it is distinct by its different mode of growth and the more irregular network that it bears on both surfaces.

3. HEXAGONELLA LÆVIGATA, Waagen & Wentzel, n. sp., Pl. CVIII, fig. 2; Pl. CXV, fig. 5.

Corallum lamelliform, forming straight leaf-shaped expansions of moderate size. Surface smooth, with a network of very faint lines, forming hexagons, within which the calices of the polypites are irregularly distributed. These lines do not project as angular ridges, but are on a level with the remainder of the surface of the corallum. At some places the surface shows fine wrinkles. Calices very small, about three within the distance of 1mm., distant from each other generally a little more than their own diameter. Shape of the calices round or oval, often, when they are still in the state of development, with two lateral projections, and then somewhat resembling the calices of *Dybowskiella*, which will be described presently. When fully developed often rather irregular in shape, but never angular. The cœnenchymal cells are very much smaller, rather unequal in size, and always angular. There are no spaces in which the cœnenchyma alone would predominate, and thus there are also no maculæ.

In transverse sections the polypites appear as comparatively wide tubes in which tabulæ are rather scarce. In the cœnenchymal tubes the walls are mostly geniculated, the tabulæ very numerous, and there are generally two to three such tubes between two polypites. As in other species of the genus so also in this one the polypites are arranged symmetrically on both sides of a thin, median, calcareous lamella.

The cœnenchymal gemmation can in this species be yet more clearly made out than in the two preceding ones, the preservation being somewhat more favourable. Sections parallel to the surface but not far from the median lamella show this gemmation in an excellent manner. Fig. 5 on Pl. CXV represents several polypites in different states of development. The median one with three sub-divisions in its interior is the youngest of all: the walls of the cœnenchymal tubes of which the new polypite has been formed are not yet re-absorbed. Next in age come the four upper polypites and one below: in these the re-absorption of the walls of the cœnenchymal tubes, which originally existed in this place, has been nearly completed, and there remain mostly two small lateral projections, though the process can also take place in a different manner, as is shown by the polypite situated in the middle of the upper part of the figure. The remaining three polypites, two on the lower part and one in the middle, have nearly completed their development. The walls of the cœnenchymal tubes have already been entirely re-absorbed, but the outline of the polypites is not yet quite regular. How typically all this agrees with what has been described and figured of *Heliolites* appears on a first glance when comparing the figures.

What size the species may have attained cannot be indicated, as no complete specimen is at our disposal. The thickness of the lamellæ varies greatly, some of them attaining a thickness of more than 5mm., whilst others are not thicker than between 2mm. and 3mm.

Locality and geological position.—Like the preceding species the present one also has been found up to the present only in the trans-Indus continuation of the Salt-range. There are only three specimens, which were all collected by Mr. Wynne in the coral beds of the middle division of the Productus-limestone. One of them came from Gulámi, the other two from Bilot.

Remarks.—To a casual observer the present species might appear to have a striking resemblance to what has been described by Trautschold from the upper carboniferous limestone of Miatchkowa under the name of *Coscinium sellæforme.* On a closer comparison, however, one finds that though on the whole a certain resemblance cannot be denied, yet there are considerable discrepancies. Both species agree in the circumstances that they form lamellar expansions composed of two layers of polypites, and that they possess a smooth surface. In the Indian form, however, a faint hexagonal network exists, which is absent in the form from Maitchkowa, and in the latter the cœnenchyma is also by far more plentiful. According to Trautschold's indication there are at least six rows of cœnenchymal cells between two polypites, whilst there are only three in *Hexagonella lævigata.* Though thus *Coscinium sellæforme* may belong to the genus *Hexagonella* yet it is a species certainly different from our *Hex. lævigata.*

From *Hexagonella tortuosa* the present species differs by the absence of prominent ridges on the surface of the corallum, by the absence of maculæ, and the more regular mode of growth.

There is apparently no other species with which the present one could be compared.

Sub-family: *FISTULIPORINÆ.*

Genus: DYBOWSKIELLA, Waagen and Wentzel, n. gen.[1]

The corallum always consists in the beginning of incrustations covering foreign bodies. This state is, however, generally only transitory, and soon the corallum becomes elevated and by-and-by forms massive stems, which can attain a thickness of 60mm. and a height of 150mm., branching irregularly in all directions. But not only in the beginning do these forms incrust foreign bodies, but also during their growth living and dead shells are incrusted, and thus one often finds hollows in the interior of these corals, which either were filled originally with soft bodies, or in which the remains of shell-bearing animals are still found, as species of *Strophalosia*, of *Streptorhynchus*, of *Richthofenia*, &c. Some species, however, never form branching stems but always appear as thin crusts.

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[1] We change the name of *Dybowskia,* given by us to these forms on page 771 of the present work, into *Dybowskiella,* after having learnt that the name *Dybowskia* has been already applied to a genus of recent Mollusks.

The surface is covered by numerous small calices, between which cœnenchyma is more or less abundantly developed. Maculæ are generally present, but monticules are only exceptionally developed.

The calices are either round and funnel-shaped or flat and bilobed. Sometimes they are slightly projecting and separated from each other by furrows.

In thin sections it appears that the polypites are provided with two strongly projecting septa, extending along the entire length of the polypites and producing the bilobed appearance of the calices. Sometimes they stop short of the mouth and thus the round calices are produced.

The cœnenchymal cells are always polygonal in tangential sections. They generally do not open on the surface but are closed by a thin calcareous lid. It is, however, very difficult to say whether this is caused solely by preservation or whether it is an original feature.

In longitudinal sections the tubes of the polypites are provided with rather distant, straight, complete tabulæ; the cœnenchymal tubes on the contrary have vaulted tabulæ in very great numbers.

The most characteristic feature of the present genus is the existence of the two septa which are very conspicuous in all the species. It cannot be denied that forms with bilobed or trilobed apertures have been known already for a considerable time, but it had not been recognised that the projecting shell parts producing the bilobed appearance of the apertures were to be considered in reality as septa-like organs. Such species have been described partly as *Alveolites*, partly as *Fistuliporæ*, by Rominger, Schlüter, and Dybowsky. In the paper containing his description, the latter expresses already the opinion that these processes had to be considered as septa; nevertheless he did not distinguish between *Fistulipora* and the species under his notice, but called the species *Fistulipora lahnseni*.

That we have really to deal here with septa, which extend through the whole length of the polypites, is demonstrated clearly, for instance, by our fig. 3 on Pl. CII, where the polypite to the left is cut just at the place where the two septa extend from both sides into the interior of the tube, and are distinguishable as thin shelly lamellæ running along both sides of the tube. The presence of septa is, however, a fact of such importance, that the forms possessing them must certainly be separated at least generically from those without them. Thus also *Fistulipora lahnseni*, Dyb., cannot remain in the genus *Fistulipora*, but has to be removed to our present genus, *Dybowskiella*.

The circumstance, however, that this species was originally described as a *Fistulipora* is already sufficient proof how nearly the present genus is related to *Fistulipora*. In fact, on a closer examination one finds that *Dybowskiella* is in all respects identical with *Fistulipora*, except in the existence of these septa. How strangely the tubes of the polypites are transformed by these septa is shown by a look at any of our plates. It often appears as if the wall of the tube were made up of two parts which do not entirely meet each other, but leave a little space free, by which the tube would communicate with the adjacent cœnenchymal cells: this appearance is figured Pl. CII, fig. 2 *a*, *c*, &c. That such openings do not exist in reality, but that this appearance is probably only brought about by a singular mode of preservation, is shown by other figures as Pl. CIV, fig. 6, Pl. CIII, fig. 1*d*, &c. Also otherwise the mode of preservation influences much the appearance of the tubes, which appearance, however, seems to depend also partly upon the age of the colonies. In young colonies apparently the walls of the tubes are simple, forming a single dark line. In somewhat older tubes secondary thickenings of the walls appear; these are first restricted to the smaller lobe of the tube connecting the two septa (Pl. CII, fig. 2*a*,); later on also the other parts of the tubes show such thickenings, which always exhibit a fine radially striated structure, Pl. CIV, fig. 1*b*. How far these thickenings were originally present, or have been caused by preservation only, is very difficult to decide.

The occurrence of two septa within these polypites is not quite without interest with regard to Lacaze Duthier's observations on the embryology of the *Cœlenterata*, in which it is shown that the young of some of the *Actinia* and *Madreporaria* first develop two septa, which are situated exactly like the septa in the polypites of *Dybowskiella*. Though the latter genus belongs to the *Alcyonaria* yet this point may just as well not be lost sight of, as perhaps in the future it might be proved that *Dybowskiella* is a persistent juvenile state or a case of atavism.

That the position of the genus *Dybowskiella* in the *Alcyonaria* is the right one cannot well be doubted, considering the mode of gemmation prevailing in the genus. In every longitudinal section it can be seen how the polypites develop out of several cœnenchymal tubes; also in transverse sections this can sometimes be observed. We have figured Pl. CIV, fig. 2*c*, a thin slide in which the process of formation of polypites can be well distinguished, and in Pl. CXV, fig. 6, we see the process of reabsorption of the cœnenchymal walls going on within the newly formed polypite.

The question of the relation of *Dybowskiella* to *Fistulipora* has been placed in a new light by Nicholson's most recent paper on the genus *Fistulipora*. We must confess that it would have saved us an enormous amount of trouble had Nicholson's former figures of *Fistulipora minor*, now *Fistulipora muscosa*, shown any traces of the "folds" that are now stated to exist in all the species of *Fistulipora*. These folds, or more properly speaking, one-sided thickenings of the walls of the tubes, are the beginnings of the bilobed development of the tubes of the polypites, as is exhibited in an extreme manner in *Dybowskiella*. The explanation of this feature that has been suggested by Mosley and Howes is of the utmost importance, and throws also some light on the circumstance, that in other forms of the *Fistuliporidæ*, as in *Hexagonella* described above, the existence of a certain propensity to assume a bilobed appearance of the polypites cannot be denied.

From Nicholson's and Foord's definition of the genus *Fistulipora* it would seem as if there were no difference between that genus and *Dybowskiella*. It appears to us, however, that there is some difference between a one-sided thickening of the tube, causing barely any prominence to be formed on the interior of the tubes, and the existence of two well-developed far projecting pseudosepta such as exist in *Dybowskiella.* If one looks through the figures accompanying Nicholson and Foord's paper on *Fistulipora,* it is very easy to make a distinction between those forms which in reality must be included in the genus *Fistulipora,* and some others that must be considered as belonging to *Dybowskiella.* To the first must be assigned all the species described in that paper, with the exception of two, *Fist. utriculus,* Roming., and *Fist. trifoliata.,* Schlüt., which on a first glance can be recognised as forming part of the genus *Dybowskiella.* It is perhaps true that the limits between the two genera cannot be easily drawn, as some transitional forms will probably exist, but then this is the general rule obtaining in palæontology. The designation of a certain form to one or the other, of allied genera is always a matter of tact and taste, as the existence of a genus, though perhaps founded in nature by descent, cannot be established in the minds of scientists except on a certain sum of variable characters. The variability of the characters already forbids the exact circumscription of any genus, and thus it is absolutely impossible that no transitional forms should exist.

This is also the case in the two genera, *Fistulipora* and *Dybowskiella.* There is, on the one hand, a great number of forms which have developed no pseudosepta, though rudiments may sometimes exist, and there is, on the other hand, a great number of forms in which distinct pseudosepta are present, for the one the name *Fistulipora,* for the other the name *Dybowskiella,* may be used, and everybody will know what is meant by the name, and this is what is chiefly required for the moment. Before we can found genera on unquestionably established descendental grounds there will yet elapse a good deal of time, if we ever shall arrive at such a point.

Nicholson and Foord state the fact, that in well-preserved specimens the thickened part of the tubes project slightly above the general surface of the corallum in the species of *Fistulipora,* and thus forms a kind of lid. We could not observe anything similar in our specimens of *Dybowskiella.* The specimens were probably not sufficiently well preserved.

The name *Dybowskia* was applied by us already a year ago in the introduction to the *Bryozoa* (*supra,* p. 771), and it was then stated that the forms belonging to the genus possessed two septa, a fact that has been overlooked by Messrs. Nicholson and Foord.

In the Salt-range the genus is very plentifully represented, but the species are new and cannot be identified with any hitherto described. It is chiefly the number of individuals that is so great, the number of species does not exceed two. These are more or less nearly related to *Dybowskiella lahnseni,* Dyb., from permian beds of Russia.

All the species occur in the middle and upper divisions of the Productus-limestone; none has been found up to the present in the lower division.

1. DYBOWSKIELLA GRANDIS, Waagen & Wentzel n. gen. et sp., Pl. CII; Pl. CIII; Pl. CIV, figs. 1-4, 7; Pl. CVI, fig. 7; CXV, fig. 6.

1863. *Alveolites septosa ?* (Flem.), Koninck: Quarterly Journ. Geol. Soc. Lond., Vol. XIX, page. 4, pl. II, fig. 1.
" " (Flem.), Koninck: Foss. paléoz. de l' Inde, p. 22, pl. II, fig. 1.

Corallum massive, forming thick cylindrical stems and branches, which frequently and quite irregularly divide, becoming thus arborescent. Height of the entire corallum up to 200mm., thickness of the stems and branches up to 60 or 70mm., but very often thinner.

Surface of the corallum generally smooth, only exceptionally, when strongly weathered, with monticules, which are very irregularly distributed. Maculæ generally present.

Calices mostly slightly elevated, sometimes separated from each other by furrows, which form an angular network. Always very small, barely more than 0·4 mm. in diameter, whilst the distance between two calices is considerably smaller. There are generally two calices within a length of 1mm. Almost always the bilobed nature of the polypites can be recognised also in the calices, where the two septa are very well distinguishable. Only in strongly weathered specimens, such as have been figured by Koninck, and are represented on our Pl. CIV, fig. 4, the calices appear sometimes deeply funnel-shaped and nearly circular.

Cœnenchymal cells angular, and very considerably smaller than the calices. There are generally not more than one or two rows of cœnenchymal cells between two calices, only in the maculæ larger masses of cells are united together.

In tangential sections the walls of the cœnenchymal cells often appear incomplete, but this is probably caused solely by a singular mode of preservation.

In transverse sections, vertical to the surface of the branches, the polypites appear as comparatively wide tubes, with not very numerous complete and mostly straight tabulæ. The cœnenchymal tubes are much narrower, with extremely numerous vaulted tabulæ and geniculated walls.

It can be very well observed that the cœnenchymal tubes augment by fissiparity and the polypites by cœnenchymal gemmation.

Very often it can be observed, that the colonies are interrupted in their growth, and new colonies grow on them quite independently, so that several layers are observable, one above the other.

In the young state the species is always incrusting, and selects chiefly bodies which are elongated or acutely conical, as the larger valve of *Richthofenia*, of *Streptorhynchus*, &c., or even soft bodies. As has been stated in the introduction to the genus, foreign bodies are also incrusted during the progress of growth. The specimen figured Pl. CII, fig. 1 seemed to form one compact mass, but when chipping off some fragments for the preparation of slices, we suddenly came upon the large cavity represented in the figure. This cavity was probably originally occupied by some soft body. One of the most strange incrustations is represented by the specimen figured Pl. CIII, fig. 1. It is pierced by several irregularly bending holes, which very probably served for the dwelling of some Annelid. The head of those animals certainly projected above the surface of the coral, and its tentacles caused a whirling current of water which was not without effect upon the animals around. They deviated from their straight direction and followed the direction of the current to a certain extent, so that they now appear as if spirally arranged.

Locality and geological position.—This is the commonest species of the genus and is found as frequently in the middle division of the Productus-limestone as in the upper division. In this latter position the species has been collected in the Cephalopoda-bed at Jabi (3 sp.) and in the same bed at Chidru (2 sp.), in the mountains east of Katwáhi (2 sp.), and at the base of the upper division at Khura (1 sp.).

In the middle division it has been found at Vurcha (3 sp.), on the road between Vurcha and Ucháli (1 sp.), at Morah (1 sp.), at Khura (1 sp.), and at Káfirkot (1 sp.).

Remarks.—The present species can be compared to two forms that have been previously described. One of them has been comprised by Dybowski under the name of ***Fistulipora lahnseni***, the other has been described by Beyrich in the genus *Alveolites*.

Dybowski has described, under the name of ***Fist. lahnseni***, two forms, one which grows in lamellæ and another which has been found to form dichotomous stems of the thickness of 10 to 12mm. It seems to us that the two cannot possibly belong to one and the same species; as the differences in the microscopical structure is generally very small in all these fossils, the different species must chiefly be distinguished according to the different mode of growth assumed by the different colonies. The name ***Dybowskiella lahnseni***, Dyb. sp., must be restricted to the lamellose forms, whilst the arborescent ones must receive a new name. It is to this arborescent form that our ***Dyb. grandis*** seems to be most nearly related, and we even are not quite certain whether the two must not in reality be considered identical. It is true our Indian fossil attains generally by far more considerable dimensions, but if this is the only difference, it can barely be considered sufficient for the distinction of a proper species. So long, however, as detailed figures and descriptions of the Russian fossil are not forthcoming nothing can be decided as to the identity of our ***Dybowskiella grandis*** and the Russian permian species.

The other form that must be compared is ***Alveolites mackloti***, Beyrich, from Timor. The calices of this species are not dissimilar to those of the present species, but one can say no more of the matter. It is not known whether a cœnenchyma exists or not, and thus comparison is fruitless.

A species that perhaps belongs to the present genus is ***Fist. incrassata***, Nich., but as a species it cannot be compared to the present one as it grows in lamellar crusts.

2. DYBOWSKIELLA EXPANSA, Waagen and Wentzel, n. gen. et. sp., Pl. CIV, figs. 5, 6, 8.

Corallum forming flattened branches or lamellar expansions, and on the whole very irregular in its growth. Size apparently much less considerable than in the preceding species but not exactly known, as only fragments are available. Surface smooth, without monticules. Maculæ of very rare occurrence. Calices slightly projecting, separated from each other by shallow furrows, somewhat smaller than in the preceding species, of a diameter of about 0·3mm., often very closely arranged so that there are frequently three calices within the distance of 1mm. The shape of the calices is either distinctly bilobed or nearly circular. Spaces between the calices occupied by angular cœnenchymal cells, which are however barely distinguishable on the surface.

In tangential sections the polypites show very clearly the two septa, except when they are not yet fully developed. The polypites are often so closely arranged, that no cœnenchyma intervenes, and the shape of the polypites is greatly altered. This is, however, only partly the case; in other parts of the same individual sometimes the cœnenchyma is developed as in the preceding species. Transverse sections show the same characters as are exhibited by other forms and have been described already in the introduction to the genus.

If the species appears in lamellar expansions, the lamellæ attain a rather considerable thickness, at least 4 to 5mm., and seem to bear calices only on one side. In the flattened branches the calices cover the entire surface, and there is no middle line from which the polypites would start, but a middle zone as in cylindrical branches. The branches are, however, mostly drawn out on one side into wing-like expansions, forming lamellæ, but they are mostly broken off. These lamellæ also bear calices only on one side. The largest branching specimen is 37mm. in its larger diameter, and only 16mm. in the opposite direction. Its length is 61mm.

Locality and geological position.—The present species is a rather rare one and has also a rather limited geological range. It begins in the uppermost layers of the middle Productus-limestone, in which position it has been found in the section at Khura (1 sp.). It is more numerous in the lowest beds of the upper division, where it has been collected in the same section at Khura (3 sp.); another specimen was found by Mr. Wynne at Bilot.

Remarks.—The species here under consideration is very nearly related to the preceding one, and in microscopical structure there is no great difference to be found, except perhaps the more reduced development of the cœnenchyma. The mode of growth is, however, entirely different. Whilst *Dyb. grandis*, W. & W., forms always cylindrical or branching masses in which the branches are again approximately so, and the young individuals are always parasitical, incrusting foreign bodies, in the present species the branches are always flattened and tortuous, and the young individuals are always lamellar, not parasitical, only changing slowly into the branching form. This entirely different mode of growth is, we think, sufficient for the distinction of a proper species and thus we introduce a new name for it.

There has no form been described up to the present with which our *Dyb. expansa* could be compared more in particular, as *Dyb., lahnseni*, Dyb. sp., which is also lamellar, has by far thinner lamellæ.

Genus: FISTULIPORA, McCoy.

It is only after the new definition of the genus *Fistulipora* by Nicholson and Foord, that we must admit the existence of a species belonging to it in the Salt-range. The descriptions of the genus in the former publications of Mr. Nicholson gave no hint as to the existence in this genus of organs more or less similar to the pseudosepta occurring in *Dybowskiella*, and thus nobody had an idea of the real characters of the genus. We had therefore not considered any of the species occurring in the Salt-range as belonging to *Fistulipora* but had them all placed in *Dybowskiella*. Now the case is different. The genus must now be defined in the following manner.

Corallum consisting of two sets of tubes, smaller ones that occur in great number and form a kind of cœnenchyma (" mesopores " Nicholson and Foord), and larger ones which are less numerous ("autopores" Nicholson and Foord). The smaller tubes, forming the cœnenchyma, are generally polygonal, provided with numberless tabulæ and the walls are often geniculated or so much deformed by the inflated tabulæ that the whole forms a mass of vesicles. In this vesicular cœnenchyma, only the uppermost layer, above the last set of tabulæ, was probably inhabited by living animals. These cœnenchymal tubes augment generally by fissiparity; only exceptionally an intermural gemmation seems to take place.

The larger tubes, the autopores, are the dwellings of the fully developed animals, the autozooids. They are mostly round or oval in their transverse section (generally not bilobed) and bear on one side a kind of callosity, which at its terminations projects slightly into the interior of the tubes, forming prominent edges which extend all along the tubes. These tubes augment by cœnenchymal gemmation.

The species belonging to this genus are generally incrusting.

According to this diagnosis one of the species occurring in the Salt-range must be considered as a *Fistulipora*. On the whole the difference between *Fistulipora* and *Dybowskiella* is very small. Both belong to the same type, and it is somewhat doubtful whether we shall meet with general approval in retaining the distinction even after Mr. Nicholson's recent paper. Yet we think the name *Dybowskiella* which we introduced already a year ago, trusting in Mr. Nicholson's former publications, may be retained, as the typical species of *Fistulipora* in transverse sections never appear as if the tubes of the polypites were composed of two separated and distinct parts which is generally the case in *Dybowskiella*.

The Salt-range form appears to be a new one, though it is more or less related to several of the species of *Fistulipora* described by Nicholson and Foord.

The species occurs in the middle division of the Productus-limestone and is therefore of a permian age.

1. FISTULIPORA PARASITICA, Waagen and Wentzel, n. sp., Pl. XLV, fig. 6; Pl. CV, figs. 1-4.

Corallum always forming thin incrusting lamellæ, never appearing in free lamellæ or branches. Surface provided with numerous monticules, but rarely with maculæ. Calices small, deep, apparently round. Their diameter is about 0·2mm, and there are about three of them within a length of 1mm. They are generally a little less than their own diameter distant from each other. The space between them is, when well preserved, occupied by a fine network, in the middle of which thin shelly crests run along, forming a network of larger meshes which encircle each of the calices. These crests, if not well preserved, are transformed into fine granules, and then the spaces between the calices appear finely granulated.

In sections parallel to the surface the polypites show a pyriform outline, with two very small projections on the broader end. The cœnenchyma between them is well developed, being composed of numerous angular cells, the walls of many of which are thickened on one side in such a manner that many such thickened walls produce together calcareous lamellæ which surround the single polypites and form a polygonal network.

On account of the thinness of the colonies, it is extremely difficult to make transverse sections, in order to expose the polypites longitudinally. Our fig. 3*b*, Pl. CV, represents such a section; it is however very defective. One can only distinguish that the polypites have few straight complete tabulæ, and the septa-like projections are also partly distinguishable as thin dark lines. The cœnenchymal tubes are rather irregular, with geniculated walls and numerous tabulæ.

The materials at disposal were too scanty to make studies as to the gemmation of these fossils. From the transverse section represented in fig. 3*b*, however, it becomes highly probable that a cœnenchymal gemmation prevailed.

The size of the species was considerable, and chiefly the thickness of the lamellæ always remained very small, barely ever exceeding 1mm. The largest specimen known to us forms an incrustation on a specimen of *Spirifer musakheylensis*, Dav., and has been figured together with this latter specimen on Pl. XLV.

Locality and geological position.—There are altogether only three specimens of this species preserved in the Salt-range collection. All three were found in the middle division of the Productus-limestone; one forms an incrustation of a *Productus musakheylensis* from Chidru; the second envelopes the branching stem of a *Geinitzella* and comes from the highest beds of the middle Productus-limestone at Khura; the third incrusts a fragment of the shell of some Brachiopod and was collected by Mr. Wynne at Bilot.

Remarks.—This is one of those species which are to a certain extent transitional between *Fistulipora* and *Dybowskiella*. The shape of the polypites is that generally occurring in the former genus, whilst the existence of two pseudosepta, though they are rather rudimentary recall to a certain extent the latter. Yet the entire habitus of the form, its creeping mode of growth, and the not bilobed appearance of the polypites, are, as it seems to us, more in favour of its union with *Fistulipora* than with *Dybowskiella*, and thus we have decided on the former position for the species.

Among the species described by Nicholson and Foord in the genus there are several that are rather similar to the form here under consideration, but from all of them our *Fist. parasitica* is different by more distinctly developed pseudosepta and those prominent ridges that encircle the polypites.

Of other species hitherto described only *Fistulipora tuberosa*, Kays., shows a certain external similarity, as it also bears monticules; but the mode of growth of this form is entirely different, and the polypites seem to be devoid of any trace of pseudosepta, so that Kayser's species must be considered as a true *Callopora*.

PLATE XCVII.

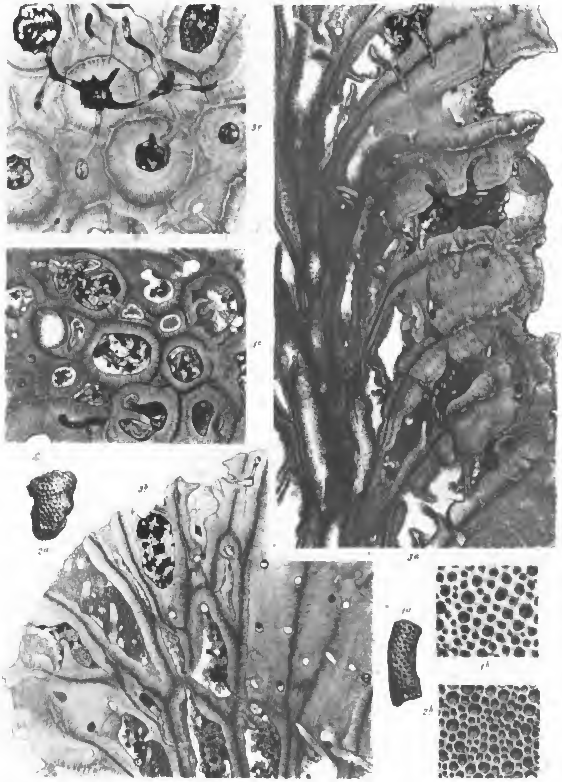
PRODUCTUS-LIMESTONE.

Figure 1 (& 3). PACHYPORA CURVATA, Waagen and Wentzel, n. sp., p. 846. Specimen, partly silicified, from the Cephalopoda-bed of the upper Productus-limestone of Jabi: 1*a*, natural size; 1*b*, part of the surface enlarged (4 times); 1*c*, tangential section strongly enlarged (50 times).

2. PACHYPORA JABIENSIS, Waagen and Wentzel, n. sp., p. 847. Specimen from the same bed and locality as the preceding: 2*a*, natural size; 2*b*, part of the surface enlarged (4 times).

3 (& 1). PACHYPORA CURVATA, Waagen and Wentzel, n. sp., p. 846. Another fragment from the same bed and locality as fig. 1: 3*a*, longitudinal section, strongly enlarged (50 times); 3*b*, part of the transverse section strongly enlarged (50 times); 3*c*, tangential section, strongly enlarged (50 times).

SALT-RANGE FOSSILS.



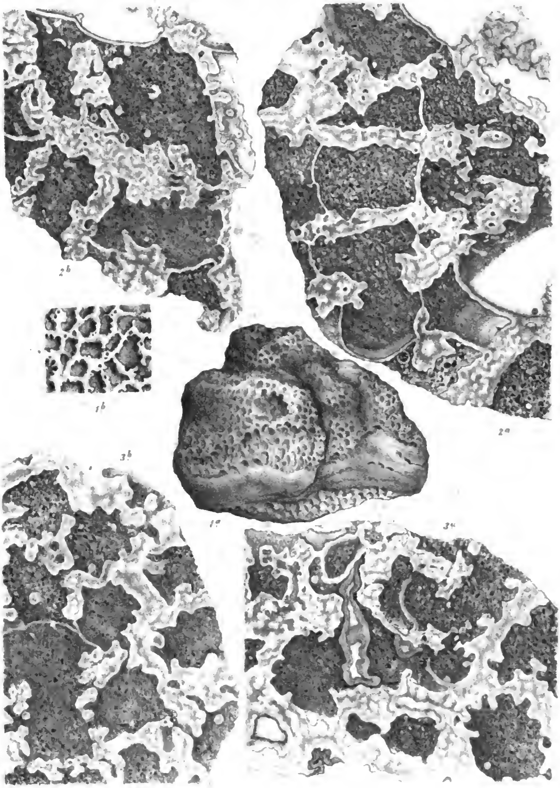
A Swoboda del et lith.

Th Bannwarth print

PLATE XCVIII.

PRODUCTUS-LIMESTONE.

Figures 1—3. ARÆOPORA TUBEROSA, Waagen and Wentzel, n. sp., p. 838. Calcareous specimen probably from the Rotta Roh and from the middle division of the Productus-limestone: 1*a*, the specimen, natural size; 1*b*, part of the surface enlarged (4 times); 2*a*, longitudinal section, exactly coinciding with the longitudinal extension of the tubes; 2*b*, longitudinal section, somewhat oblique; 3*a*, tangential section, exactly vertical to the longitudinal direction; 3*b*, tangential section, somewhat oblique; the latter four figures very strongly enlarged (30 times). (Other species of the genus are figured on Pl. CVI.)



A. Swoboda del. et lith.   Th. Bannwarth print.

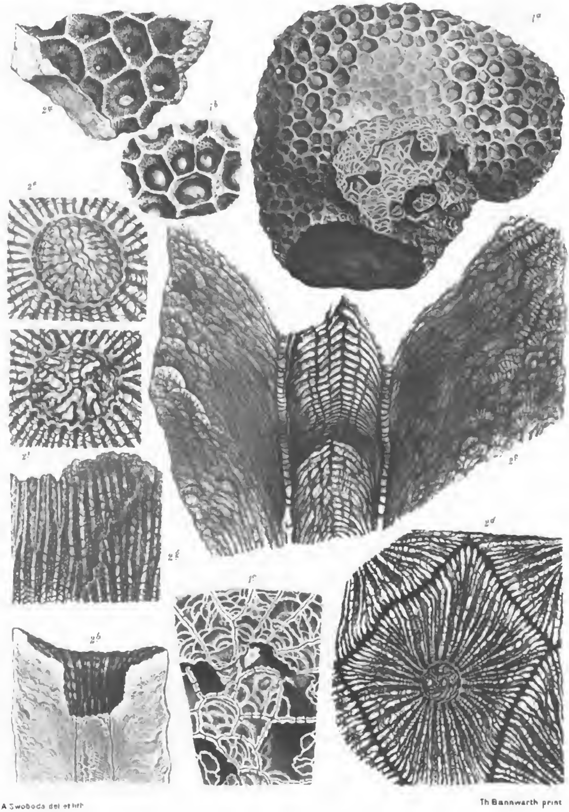
PLATE XCIX.

PRODUCTUS-LIMESTONE.

Figure 1. **Michelinia indica**, Waagen and Wentzel, n. sp., p. 858. Calcareous specimen from the middle division of the Productus-limestone of Virgal: 1*a*, the entire specimen, natural size; 1*b*, some of the calices slightly enlarged (2 times), to show the perforation of the walls; 1*c*, section slightly enlarged, to show the numerous tabulæ and the intermural gemmation. (For other species of the same genus, see in the text and on Pl. CXVI.)

2. **Lonsdaleia wynnei**, Waagen and Wentzel, n. sp., p. 896. Specimen, partly silicified, from the middle Productus-limestone of Katta: 2*a*, part of the corallum with some calices, natural size; 2*b*, natural longitudinal section of one of the corallites, slightly enlarged (4 times); 2*c*, microscopical longitudinal section of one of the corallites, strongly enlarged (30 times); 2*d*, transverse section of one of the corallites (enlarged about 5 times); 2*e*, *f*, central parts of two corallites with the collumella, strongly enlarged (30 times); 2*g*, peripheral part of a corallite, showing the structure of the septa enlarged (30 times).

SALT-RANGE FOSSILS.



A Swoboda del et lith
Th Bannwarth print

PLATE C.

PRODUCTUS-LIMESTONE.

Figure 1. Lonsdaleia salinaria, Waagen and Wentzel, n. sp., p. 895. Silicified specimen from the middle Productus-limestone of Vurcha: 1*a*, the entire corallum, natural size; 1*b*, lateral view of the same; 1*c*, two calices with the columella preserved, slightly enlarged (3 times); 1*d*, two other calices of the same specimen, the columella destroyed by weathering, slightly enlarged (3 times); 1*e*, two calices smoothed down by weathering, slightly enlarged (3 times).

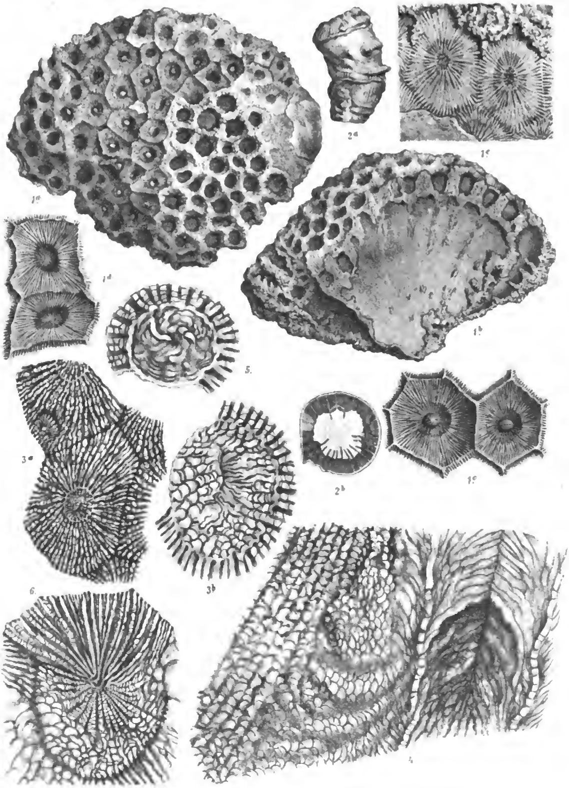
2. Amplexus cristatus, Waagen and Wentzel, n. sp., p. 902. Specimen from the middle Productus-limestone of Káfirkót: 2*a*, lateral view, natural size; 2*b*, section at lower extremity, slightly enlarged (2 times).

3, 4. Lonsdaleia salinaria, Waagen and Wentzel, n. sp., p. 895. Different microscopical sections taken from the specimen represented in fig. 1: 3*a*, two calices, with a gem in one of them in process of development, enlarged (about 5 times); 3*b*, central part of one of the calices with the columella, strongly enlarged (about 40 times); 4, longitudinal section of one of the corallites, enlarged (about 40 times).

5, 6. Lonsdaleia wynnei, Waagen and Wentzel, n. sp., p. 896. Microscopical sections of a specimen from Katta: 5, central part of one of the calices showing the twisted columella, strongly enlarged (about 30 times); 6, transverse section of a corallite with strangely-developed vesicular tissue, enlarged (about 5 times).

Geol. Surv. of India. Pl C.

SALT-RANGE FOSSILS.



A Swoboda del et lith
Th Bannwarth print

PLATE CI.

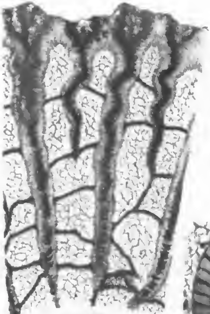
PRODUCTUS-LIMESTONE.

Figures 1—3. **Lonsdaleia indica**, Waagen and Wentzel, n. sp., p. 897. Fig. 1, specimen from the middle Productus-limestone on the road from Chidru to Musakheyl: 1*a*, lateral view, natural size; 1*b*, top-view, natural size; 1*c*, transverse section of a corallite, strongly enlarged (about 20 times); 1*d*, longitudinal section of a corallite, not quite median, cutting the columella somewhat laterally, strongly enlarged (about 40 times). (This figure has been inadvertently reversed.) Fig. 2, isolated corallite, from the middle Productus-limestone of the Chittawán, natural size. Fig. 3, sections of a corallite from the same locality as fig. 1: 3*a*, the columella, very strongly enlarged (80 times); 3*b*, peripheral part of the section, also very strongly enlarged (80 times); 3*c*, longitudinal section, cutting just the middle of the axis (enlarged 40 times). (This figure has also been reversed.)

4. **Lonsdaleia virgalensis**, Waagen and Wentzel, n. sp., p. 900. Transeverse section of two corallites from a specimen from the middle Productus-limestone of Virgal, strongly enlarged (about 15 times). (See other figures of the same species, Pl. CXVI, fig. 2.)

SALT-RANGE FOSSILS.

3b



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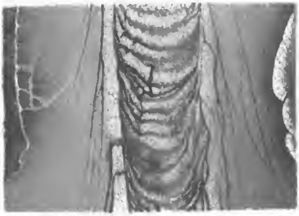

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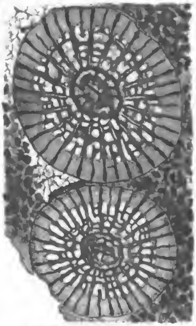

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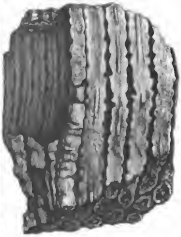

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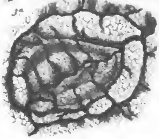

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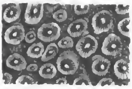

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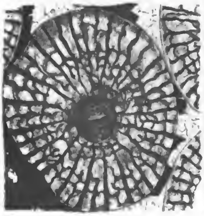

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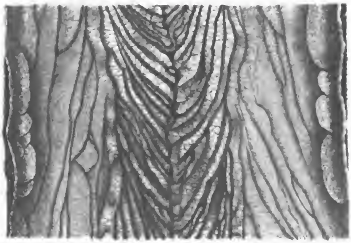


A Swoboda del et lith.

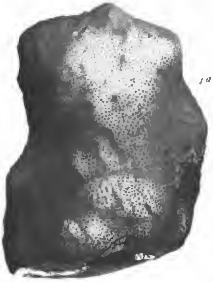
Th Bannwarth print

PLATE CII.

PRODUCTUS-LIMESTONE.

Figures 1—3. DYBOWSKIELLA GRANDIS, Waagen and Wentzel, n. gen. et sp., p. 919. Large specimen from the middle Productus-limestone of Morah. Fig. 1*a*, the entire specimen, lateral view, natural size; 1*b*, fracture at the lower extremity of the specimen, showing the central cavity, natural size; 1*c*, part of the surface enlarged (10 times), showing one of the maculæ, the openings of the polypites are closed by a vaulted calcareous lamella; 1*d*, other part of the surface enlarged (10 times), with one of the maculæ and the openings of the polypites not closed. Fig. 2, microscopical tangential sections of the same specimen, enlarged (80 times): 2*a*, the smaller lobe of the tubes of the polypites shows a secondary thickening; 2*c*, cœnenchyma as exposed in one of the maculæ; many of the cells appear incomplete, which is either caused by unsatisfactory preservation or is a sign of fissiparity (?); 2*b*, showing the normal development of the polypites. Fig. 3, part of a microscopical transverse section, exposing the tubes of the polypites as well as those of the cœnenchyma longitudinally. The cœnenchymal tubes have very numerous tabulæ; in the tubes of the polypites the tabulæ are much less numerous and the two pseudosepta can partly be distinguished.

SALT-RANGE FOSSILS.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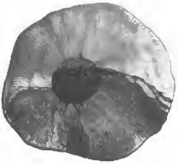
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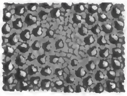
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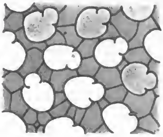
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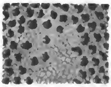
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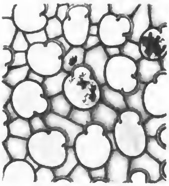
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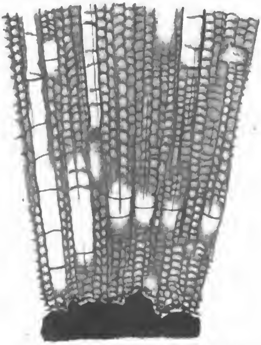
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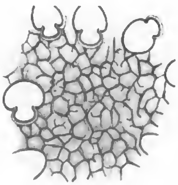

2c

A Swoboda del et lith

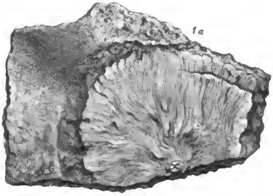
Th Bannwarth pnxt.

PLATE CIII.

PRODUCTUS-LIMESTONE.

Figure 1. **Dybowskiella grandis**, Waagen and Wentzel, n. gen. et sp., p. 919. Specimen from the middle Productus-limestone of Káfirkót, chiefly remarkable on account of the waving direction of the tubes, around holes that pierce the whole specimen and which probably were inhabited by some Annelid: 1*a* and *b*, different views of the specimen, natural size; 1*c*, part of the surface enlarged (10 times); 1*d*, microscopical tangential section; 1*e*, microscopical longitudinal section of the tubes; 1*f*, section showing two colonies superimposing each other and at the same time giving a clear view of cœnenchymal gemmation as appearing in longitudinal sections. The latter three figures enlarged 80 times.

SALT-RANGE FOSSILS.



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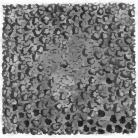

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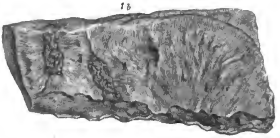

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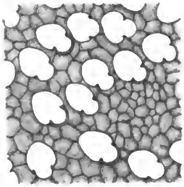

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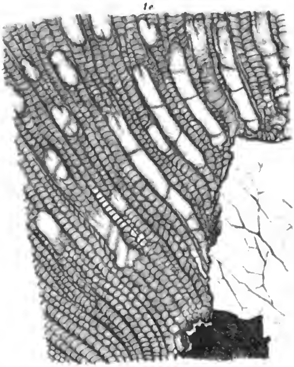

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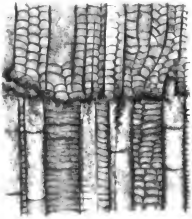

1f

A. Swoboda del et lith.

Th. Bannwarth print.

PLATE CIV.

PRODUCTUS-LIMESTONE.

Figures 1—4 (& 7). DYBOWSKIELLA GRANDIS, Waagen and Wentzel, n. gen. et sp., p. 919. Fig. 1 specimen from the Cephalopoda-bed of the upper Productus-limestone of Jabi bearing at its upper extremity parasitical specimens of *Strophalosia*: 1*a*, the entire specimen, natural size; 1*b*, microscopical tangential section (enlarged 80 times). The tubes of the polypites show secondary thickenings of the walls all round. Fig. 2, specimen from the upper Productus-limestone of the mountains east of Katwáhi; 2*a*, entire specimen, natural size; 2*b*, central part of one of the natural fractures enlarged (2 times); 2*c*, microscopical section of the central part of the stems, showing many of the tubes of the polypites in progress of development, enlarged 50 times. Fig. 3, specimen from the upper region of the middle Productus-limestone of Musahkeyl: 3*a*, the entire specimen, natural size; 3*b*, part of the well-preserved surface, enlarged 10 times. Fig. 4, specimen from the middle Productus-limestone of Morah, strongly weathered; 4*a*, the entire specimen, natural size; 4*b*, part of the surface, enlarged 10 times.

5, 6 (& 8). DYBOWSKIELLA EXPANSA, Waagen and Wentzel, n. gen. et sp., p. 921. Specimen from the base of the upper Productus-limestone west of Khura: 5*a*, the entire specimen, natural size; 5*b*, microscopical tangential section, some of the polypites in the progress of development; 6, another microscopical tangential section, the latter two figures enlarged 80 times.

7 (& 1—4). DYBOWSKIELLA GRANDIS, Waagen and Wentzel, n. gen. et sp., p. 919. Part of the natural fracture of a specimen from the upper Productus-limestone of Jabi, showing the internal casts of the tubes, enlarged.

8 (& 5, 6.) DYBOWSKIELLA EXPANSA, Waagen and Wentzel, n. gen. et sp., p. 921. Lamellar specimen from the upper limit of the middle Productus-limestone of Khura, natural size.

SALT-RANGE FOSSILS.

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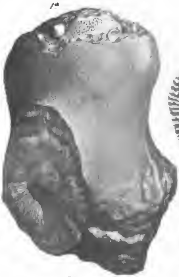

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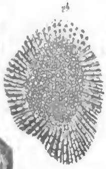

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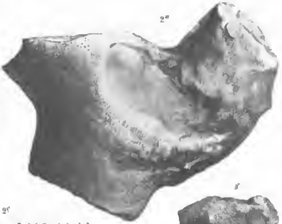

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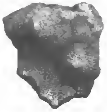

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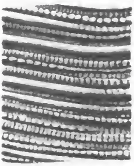

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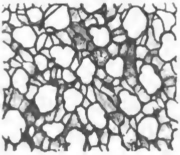

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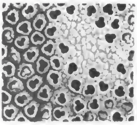

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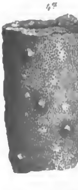

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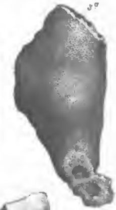

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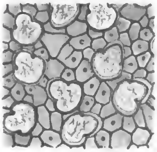

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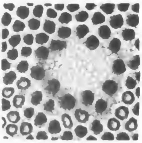

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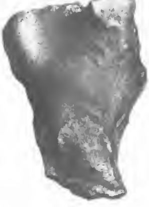

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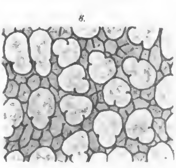

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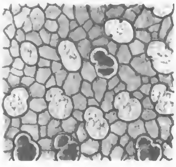


A Swoboda del. et lith.

Th. Bannwarth print.

PLATE CV.

PRODUCTUS-LIMESTONE.

Figures 1—4. **Fistulipora parasitica**, Waagen and Wentzel, n. sp., p. 923.

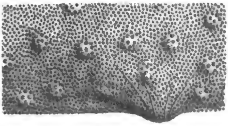
1. specimen from the middle division of the Productus-limestone of Chidru (same specimen as that figured Pl. XLV, fig. 6): 1*a*, part of the specimen enlarged (10 times); 1*b*, part of the surface, yet more strongly enlarged (25 times).

2. Fragment of a specimen incrusting the shell of some Brachiopod, from the crinoidal cliffs of the middle Productus-limestone of Bilot: 2*a*, *b*, different views of the fragment, natural size; 2*c*, lateral view, enlarged; 2*d*, microscopical section (enlarged 50 times), parallel to the surface; 2*e*, part of the surface enlarged (25 times); 2*f*, oblique section showing some tabulæ in the upper polypite tubes (enlarged 50 times).

3. Specimen from the middle Productus-limestone of Khura incrusting a stem of *Geinitzella columnaris*: 3*a*, natural size; 3*b*, longitudinal microscopical section (enlarged 50 times); 3*c*, oblique section, the lower part belonging to *Geinitzella*, the upper to *Fistulipora*; 3*d*, tangential section of the specimen of *Geinitzella ramosa* on which the Fistulipora rests (enlarged 80 times).

4. Natural fracture of the specimen, enlarged (badly represented).

SALT-RANGE FOSSILS.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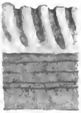
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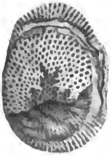
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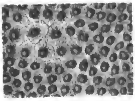
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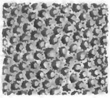
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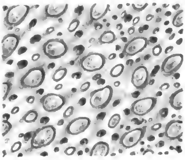
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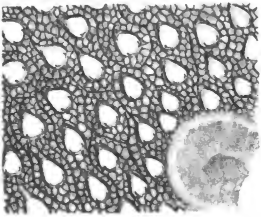
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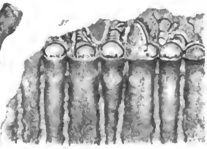
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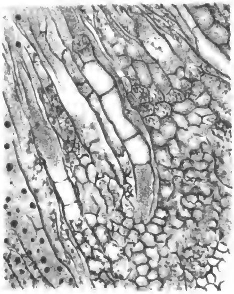
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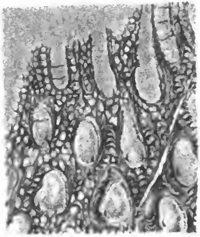
2b


2f

A Swoboda del et lith

Th Bannwarth print

PLATE CVI.

PRODUCTUS-LIMESTONE.

Figure 1. MONOTRYPA MASTOIDEA, Waagen and Wentzel, n. sp., p. 876. Fragmentary specimen from the lower Productus-limestone of Amb, natural size (for other figures of the same specimen, see the text and Pl. CXV).

2. STENOPORA HEMISPHÆRICA, Waagen and Wentzel, n. sp., p. 891. Specimen from the lower Productus-limestone of Amb; natural size.

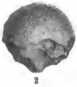
3, 4. HEXAGONELLA RAMOSA, Waagen and Wentzel, n. gen. et sp., p. 912. Two sections of a specimen from the middle Productus-limestone of Khura: 3, longitudinal section vertical to the median plane; 4, longitudinal section parallel to and very near the median plane, showing that the first layer consists of nearly equal cœnenchymal cells. Both figures enlarged 50 times.

5, 6. GEINITZELLA COLUMNARIS, Schlotheim, sp. *var. incrustans*, Gein., p. 882. Longitudinal sections of a specimen from the Cephalopoda-bed of the upper Productus-limestone of Chidru. Both figures enlarged 50 times.

7. DYBOWSKIELLA GRANDIS, Waagen and Wentzel, n. gen. et sp., p. 919. Longitudinal section of the central part of a stem, somewhat oblique, from the middle Productus-limestone of Morah. Enlarged 50 times.

8, 9. ARÆOPORA RAMOSA, Waagen and Wentzel, n. sp., p. 839. Fig. 8, specimen from the upper Productus-limestone at Khura, natural size; Fig. 9, another specimen from the upper Productus-limestone of Vurcha, also natural size.

SALT-RANGE FOSSILS.



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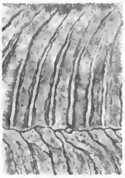

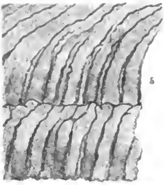

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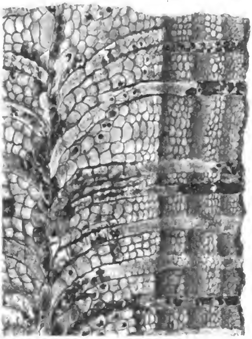

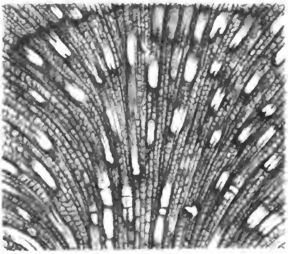

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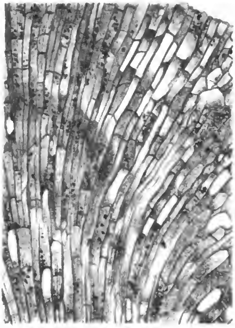

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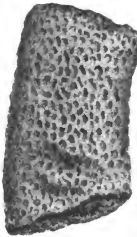

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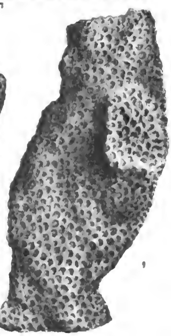


9

A. Swoboda del et lith.

Th. Bannwarth print.

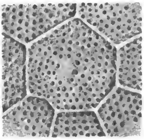
PLATE CVII.

PRODUCTUS-LIMESTONE.

Figures 1—3. **HEXAGONELLA RAMOSA**, Waagen and Wentzel, n. gen. et sp., p. 912.

1. Specimen from the upper region of the middle Productus-limestone of Musakheyl: 1*a*, lateral view, natural size; 1*b*, fracture, natural size; 1*c*, the same enlarged (4 times); 1*d*, part of the surface enlarged 5 times.
2. Specimen from the Cephalopoda-bed of the upper Productus-limestone of Chidru: 2*a*, lateral view, natural size; 2*b*, *c*, parts of the surface enlarged 5 times.
3. Sections of a specimen from the middle Productus-limestone on the road between Vurcha and Ucháli: 3*a*, *b*, tangential sections, parallel to the surface (enlarged 50 times); 3*c*, longitudinal section, vertical to the median plane (enlarged 80 times).

SALT-RANGE FOSSILS.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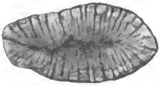
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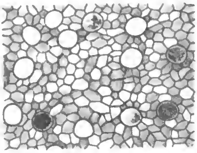
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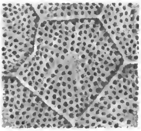
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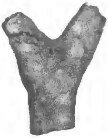
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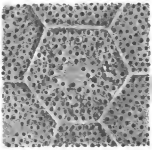
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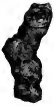
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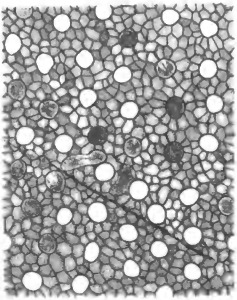
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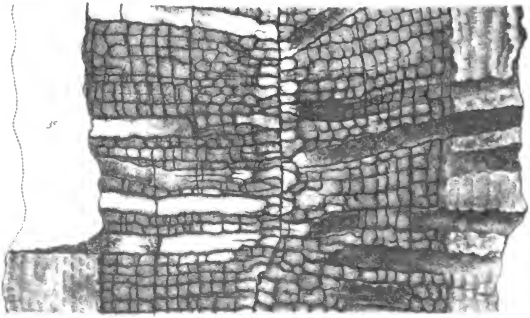
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A Swoboda del et lith

Th Bannwarth print

PLATE CVIII.

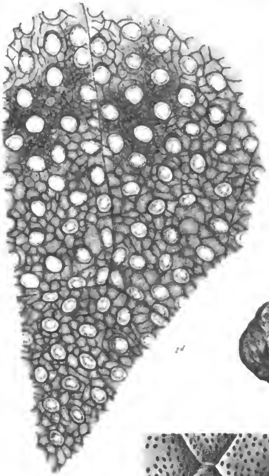
PRODUCTUS-LIMESTONE.

Figure 1 (& 3—5). HEXAGONELLA TORTUOSA, Waagen and Wentzel, n. gen. et sp., p. 914. Specimen from the middle Productus-limestone of Bilot, only the transverse fracture exposed to view: 1*a*, natural size; 1*b*, the same enlarged (5 times); 1*c*, microscopical section of the same (enlarged 50 times).

2. HEXAGONELLA LÆVIGATA, Waagen and Wentzel, n. gen. et sp., p. 915. Specimen from the middle Productus-limestone of Gulámi: 2*a*, the entire specimen, natural size; 2*b*, *c*, parts of the surface, enlarged (5 times); 2*d*, microscopical section, parallel to the surface, enlarged 50 times (see also Pl. CXV, fig. 5).

3—5 (& 1). HEXAGONELLA TORTUOSA, Waagen and Wentzel, n. gen. et sp., p. 914. Specimens from the middle Productus-limestone of Bilot: Fig. 3, specimen exposing only the transverse fractures to view, natural size. Fig. 4, the upper surface of another specimen, enlarged about 5 times. Fig. 5, other specimen exposing again only the transverse fractures.

SALT-RANGE FOSSILS.



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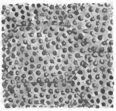

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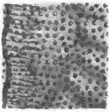

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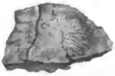

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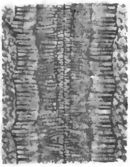

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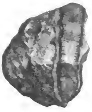

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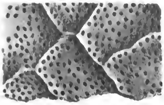

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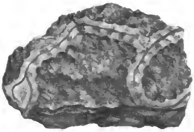

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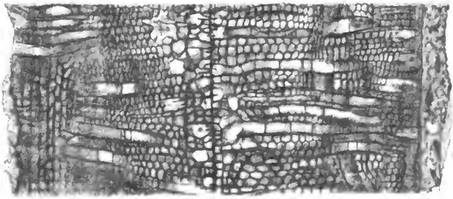

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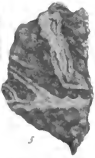


5

A Swoboda del et lith

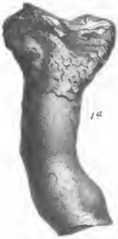
Th Bannwarth print

PLATE CIX.

PRODUCTUS-LIMESTONE.

Figures 1—3. **STENOPORA NICHOLSONI**, Waagen and Wentzel, n. sp., p. 889. Specimen from the middle Productus-limestone of the mountains east of Katwáhi: **1a**, the entire specimen, natural size; **1b**, fracture at the lower extremity of the specimen, natural size; **1c**, the same enlarged (3 times), showing the internal casts of the tubes; **1d**, part of the surface, enlarged (10 times); **2a**, microscopical tangential section, the primordial walls resolved into dotted lines (enlarged 80 times); **2b**, oblique section, showing the structure of the walls (enlarged 80 times); fig. **3**, transverse section of the stem of the corallum; **3a**, part not far from the centre; **3b**, peripheral part, showing the incrustation of the stem by *Stenopora ovata*. The latter two figures enlarged 50 times.

SALT-RANGE FOSSILS.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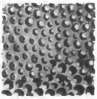
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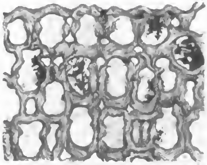
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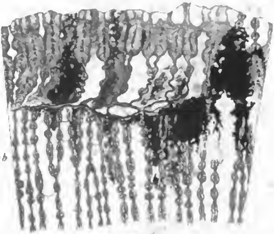
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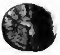
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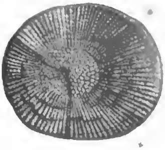
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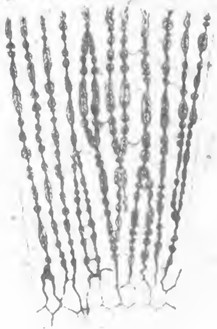
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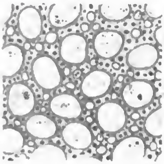

2a

R. Swoboda del et lith

Th. Bannwarth print

PLATE CX.

PRODUCTUS-LIMESTONE.

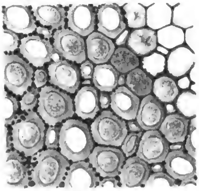
Figures 1—3. **Stenopora ovata**, Lonsdale, p. 888.

1. Specimen from the upper Productus-limestone of Nanga: 1*a*, natural size; 1*b*, part of the surface enlarged (10 times); 1*c*, tangential section, the primordial walls partly well preserved, partly dissolved into dotted lines; 1*d*, transverse section, cutting the corallites longitudinally, and showing the thickenings of the walls, the latter two figures strongly enlarged (80 times).

2. Specimen from the upper Productus-limestone above the Cephalopoda-bed of Jabi; 2*a*, natural size; 2*b*, transverse section, showing the central part of the colony as well as the peripheral one; in the latter an incrustation forming a new colony; the central cells are filled with fibrous calcspar; 2*c*, another transverse section in all respects similar to the preceding one. The latter two figures enlarged 50 times.

3. Specimen from the middle Productus-limestone of Kiri; 3*a*, natural size; 3*b*, part of the surface enlarged (10 times); 3*c*, tangential section showing the process of gemmation particularly clearly. The thickenings preceding gemmation appear somewhat thicker than they are in reality, owing to the accumulation of mineral matter on them; 3*d*, *e*, transverse sections, cutting the corallites longitudinally; 3*d*, quite peripheral part; 3*e*, part more towards the centre of the colony. The latter three figures enlarged 80 times.

SALT-RANGE FOSSILS.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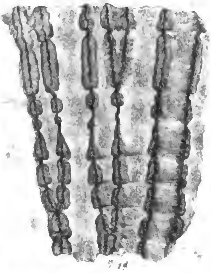
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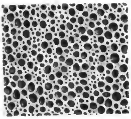
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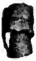
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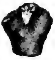
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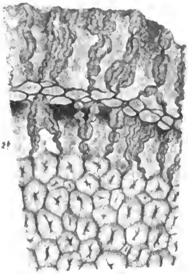
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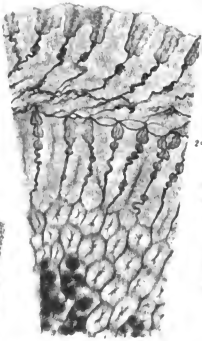
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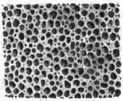
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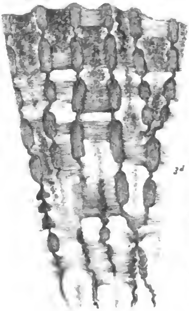
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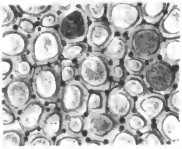
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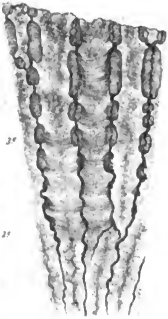
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A. Swoboda del. et lith.

Th. Bannwarth print.

PLATE CXI.

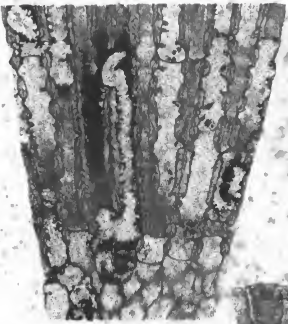
PRODUCTUS-LIMESTONE.

Figures 1, 2. **Stenopora chætetiformis**, Waagen and Wentzel, n. sp., p. 890.

1. Specimen from the upper Productus-limestone of Khund Ghât: 1*a*, natural longitudinal fracture of one of the branches, showing the corallites as internal casts, enlarged (10 times); 1*b*, oblique section, showing the structure of the walls; 1*c*, transverse section cutting the corallites longitudinally, showing tabulæ and numerous septal spines on the wall of one of the tubes. The latter two figures enlarged 90 times.

2. Specimen from the upper Productus-limestone above the Cephalopoda-bed of Jabi: 2*a*, natural size; 2*b*, part of the surface enlarged (10 times); 2*c*, tangential section, showing septal spines at different places. The primordial walls have been destroyed by fossilisation; 2*d*, transverse section showing part of the central and peripheral zones of the colony, tabulæ and septal spines well developed. The latter two figures enlarged 80 times.

SALT-RANGE FOSSILS.



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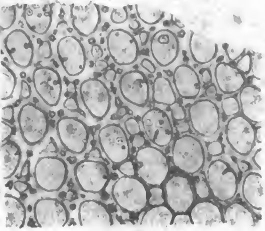

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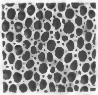

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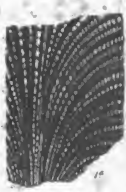

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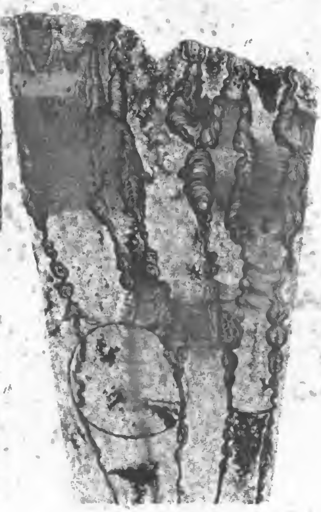

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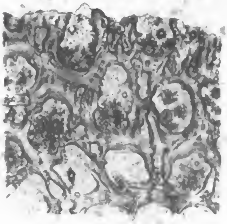


1b

A Swoboda del et lith.

Th Bannwarth print.

PLATE CXII.

PERMIAN BEDS OF EUROPE.

Figures 1—5. **Geinitzella columnaris**, Schlotheim, sp., p. 882. Specimens from the lower Zechstein of Röpsen near Gera (Germany).

1. Var. *ramosa sparsigemmata:* 1*a*, natural size; 1*b*, natural transverse section enlarged; 1*c*, part of the surface enlarged (30 times); 1*d*, central part of the transverse section, showing in the middle a transversely cut spine of *Productus horridus*, on which the specimen has settled, enlarged 80 times.

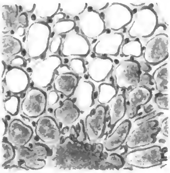
2. Var. *ramosa multigemmata:* 2*a*, natural size; 2*b*, part of the surface enlarged (30 times); 2*c*, peripheral part of the transverse section, showing the thickenings of the primordial walls preceding gemmation, extending over long distances (enlarged 80 times); 2*d*, central part of the transverse section, showing also in the corners, where the corallites meet, the thickenings preceding gemmation (enlarged 80 times).

3. Other specimen, with a foreign body in the middle, and a new colony growing on the surface of the first, transverse section, not very strongly enlarged (50 times).

4. Tangential section of the var. *sparsigemmata*, the buds in different stages of development.

5. Other specimen growing on a foreign body. The latter two figures enlarged 80 times.

SALT-RANGE FOSSILS.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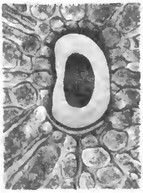
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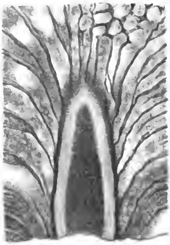
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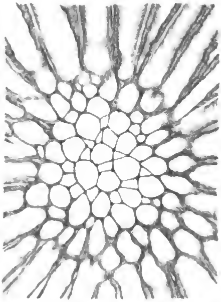
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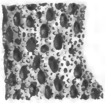
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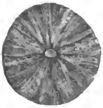
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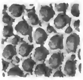
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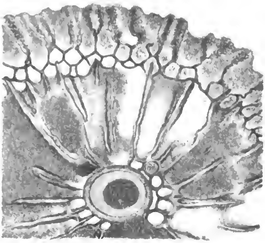
1a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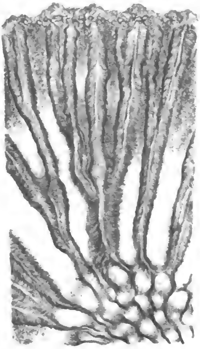

2c

A Swoboda del et lith.

Th Bannwarth print

PLATE CXIII.

PRODUCTUS-LIMESTONE.

Figures 1—4. **Geinitzella columnaris**, Schlotheim, sp., p. 882.

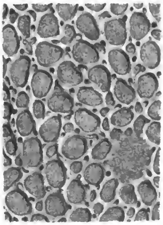
1. Var. *ramosa sparsigemmata*, specimen from the top beds of the middle division of the Productus-limestone of Khura: 1*a*, natural size; 1*b*, fracture, somewhat enlarged (5 times); 1*c*, part of the surface enlarged (15 times); 1*d*, tangential section, showing the process of gemmation, the primordial walls being, however, not distinguishable; 1*e*, transverse section, showing part of the central and peripheral zones; the thickenings of the primordial walls are very conspicuous; 1*f*, oblique section. The latter three figures enlarged 80 times.

2. Var. *ramosa multigemmata*, specimen from Dr. Verchere's collection: 2*a*, natural size; 2*b*, part of the surface enlarged (30 times), showing the process of gemmation.

3. Tangential section of another specimen.

4. Longitudinal section of a third specimen, showing the thickenings of the primordial walls. The latter two figures enlarged 50 times.

SALT-RANGE FOSSILS.



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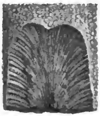

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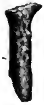

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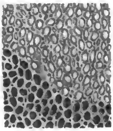

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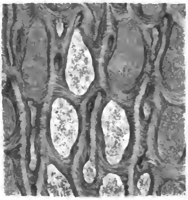

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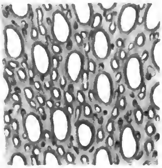
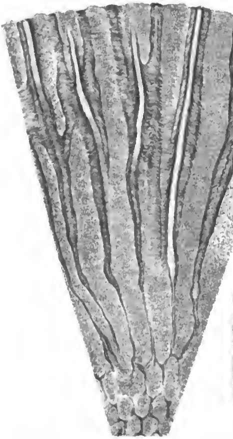


1e



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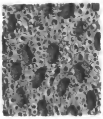

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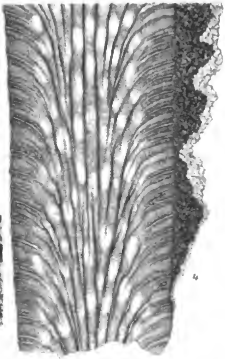

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J. Swoboda del et lith.

Th. Bannwarth print.

PLATE CXIV

PRODUCTUS-LIMESTONE.

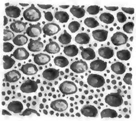
Figures 1—3. **GEINITZELLA CRASSA**, Lonsdale, sp., p. 884.

1, 2. Specimens from the upper Productus-limestone of Jabi: 1*a*, natural size; 1*b*, part of the surface enlarged (10 times); 1*c*, tangential section, the primordial walls not distinguishable (enlarged 80 times); 1*d*, transverse section, showing part of the central and the peripheral zones, enlarged 80 times; 2*a*, another specimen, natural size; 2*b*, part of the surface enlarged (30 times); 2*c*, tangential section with traces of the primordial walls preserved, enlarged 80 times; 2*d*, transverse section, showing the peripheral zone only, cutting the corallites longitudinally and bearing on its outer surface an incrustation consisting probably of the same species, enlarged 80 times.

3. Specimen from the Cephalopoda-bed of the upper Productus-limestone of Chidru: 3*a*, natural size; 3*b*, transverse section, showing the central and the peripheral zones, and on the outer surface an incrustation made up of a specimen of *Dybowskiella grandis*, enlarged 80 times.

SALT-RANGE FOSSILS.

2 b



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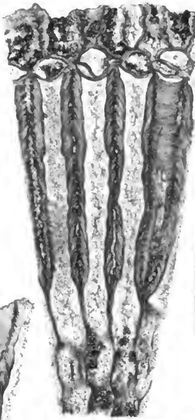
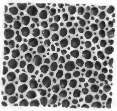


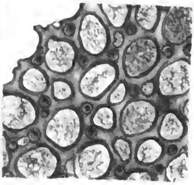
1 b



2 e

1 a

1 c



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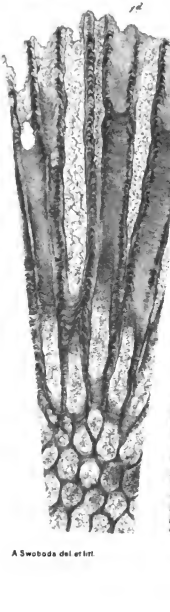
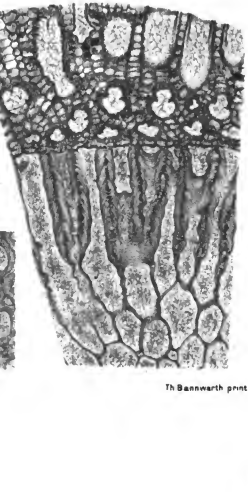


3 a

3 b



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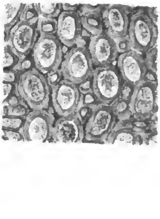


A Swoboda del. et lith.

Th. Bannwarth print.

PLATE CXV.

PRODUCTUS-LIMESTONE.

Figure 1. Geinitzella columnaris, Schloth., sp., p. 882. Tangential section of a specimen from the Cephalopoda-bed of the upper Productus-limestone of Chidru, full of the holes of boring animals, which not only pierce the tissue of the coral but also the stony matter filling up the corallites, strongly enlarged (about 80 times).

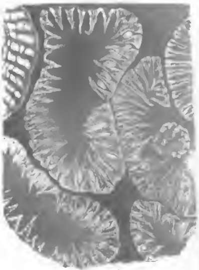
2. Orbipora ambiensis, Waagen and Wentzel, n. sp., p. 878. Microscopical sections of a specimen from the lower Productus-limestone of Amb; *2a*, tangential section, the primordial wall appearing as a white line; *2b*, part of the longitudinal section; both strongly enlarged (about 80 times).

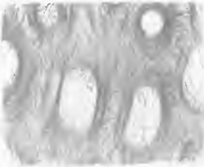
3, 4. Lonsdaleia indica, Waagen and Wentzel, n. sp., p. 897. Specimens from the middle Productus-limestone of Chidru; 3, young corallites in the process of development; still partly without a columella, transverse section; 4, an adult corallite with two gems on it, longitudinal section, both not very strongly enlarged (about 20 times).

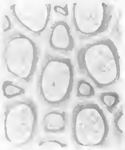
5. Hexagonella lævigata, Waagen and Wentzel, n. gen. et sp., p. 915. Section parallel to the surface, not far from the median lamella, showing the cœnenchymal gemmation of the tubes of the polypites, strongly enlarged (about 80 times); from a specimen of the middle Productus-limestone of Gulámi.

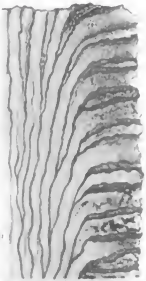
6. Dibowskiella grandis, Waagen and Wentzel, n. gen. et sp., p. 919. Tangential section showing the cœnenchymal gemmation of the tubes of the polypites, strongly enlarged (about 50 times).

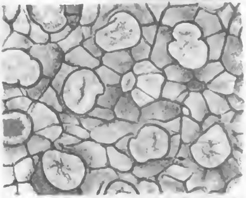
7. Monotrypa mastoidea, Waagen and Wentzel, n. sp., p. 876. Longitudinal section of the specimen from the lower Productus-limestone of Amb; strongly enlarged (about 80 times).

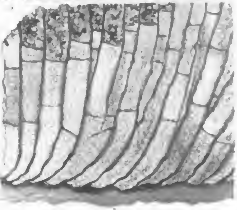












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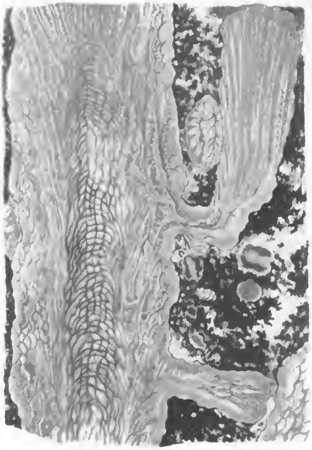

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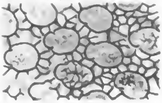

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PLATE CXVI.

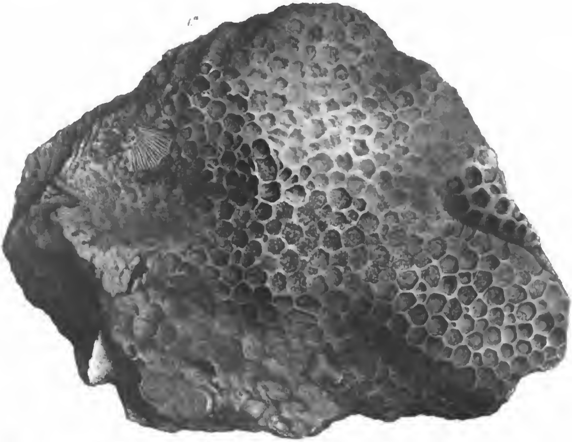
PRODUCTUS-LIMESTONE.

Figure

1. **Michelinia** cf. **glomerata**, McCoy, p. 854. Specimen from the middle Productus-limestone of Morah: 1*a*, the entire corallum, natural size; 1*b*, section through the corallum, not very distinct, also natural size. (The cells towards the middle are represented on the whole somewhat too large.)

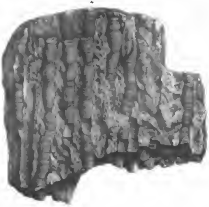
2. **Lonsdaleia virgalensis**, Waagen and Wentzel, n. sp., p. 900. Specimen from the middle Productus-limestone of Virgal: 2*a*, lateral view, natural size; 2*b*, top view, natural size; 2*c*, longitudinal section through one of the corallites, just median, not very strongly enlarged (about 6 times). (See also Pl. CI, fig. 4.)

1a



1b

2a



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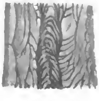

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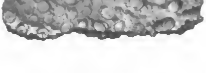

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CALCUTTA, *May 1885.*

J C Branner

MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. XIII. SALT-RANGE FOSSILS

by **WILLIAM WAAGEN, Ph.D., F.G.S.,**

Professor of Mineralogy and Geology at the I. R. German Polytechnic University of Prag.

I. PRODUCTUS-LIMESTONE FOSSILS:

7. CŒLENTERATA—AMORPHOZOA—PROTOZOA.

WITH PLATES CXVII—CXXVIII.

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Class: HYDROZOA.

Order: HYDROIDA.

Sub-Order: HYDROCORALLINA.

Family: *CŒNOSTROMIDÆ*, Waagen & Wentzel.

In taking up the study of the *Hydrozoa*, we encountered nearly insurmountable difficulties, as everything we took in hand would in no way agree with things already described; even after we had extended our studies to devonian specimens of true *Stromatoporidæ*, we were not much better off, as several of the characters which had till then been considered essential to the *Stromatoporidæ* could not be so recognised by us. In Zittel's Handbook, as well as in Nicholson and Murie's long paper on the subject, the *Stromatoporidæ* are described as composed of compact concentric lamellæ, supported on vertical pillars or rods, and leaving between them room for the sarcodic substance of the animal. Though it cannot be denied that in certain forms, such as *Ellipsactinia, Parkeria, Loftusia*, etc., such laminæ occur, yet in *Stromatopora* proper we failed to detect them. We must confess to having felt very uneasy on this account, and with great reluctance we accepted the fact which presented itself to us, and which could not be denied, though we made preparations over and over again and examined all our materials repeatedly.

We must then divide all the forms that are considered to be more or less nearly related to *Stromatopora* into two large groups; *viz.*, forms whose skeleton consists in reality of more or less compact concentric lamellæ, which are irregularly but not too frequently perforated, and are supported on vertical pillars; and, on the other hand, forms whose skeleton is composed of variously bent trabeculæ, disposed more or less distinctly in concentric layers, and leaving between them a system of reticulate or more or less vermiculate canals.

It is only the latter that we consider as belonging to the *Stromatoporidæ* in a wider sense, whilst the former compose a group that we consider with some hesitation as perhaps related to a certain extent to the *Hydractinidæ* and allied forms.

The observation that the skeleton of *Stromatopora* is not composed of compact lamellæ, but of successive sets of trabeculæ arranged more or less in one plane, so that in sections vertical to the surface of the hydrophyton a distinct lamination appears, which, however, does not exist in reality, but is only an apparent one, has been recorded already by Carter (hexactinellid structure), Bargatzky, and chiefly by Eugenia Solomko, who in her description of the "Stromatoporen des russischen Devons" says that the *Stromatoporæ* (which are taken by her to be *Pharetrones*) consist of horizontal, wavy, concentrically arranged rods which send out offshoots in a vertical direction and are thus united, leaving irregular spaces between them.

(Stromatopori Devonskoi Sistemi Rossii, page 11). This definition comes very near the truth, as we shall presently have occasion to demonstrate.

We start in the description of the different parts of the *Stromatoporidæ* from *Stromatopora concentrica*, of which species excellently preserved specimens are at our disposal. This species is on several accounts of great importance in this question; first, because it is the typical species of the genus (and not *Str. polymorpha* Gdf., as indicated by Nicholson); and, second, because in this species the so-called lamellæ deviate but very little from the horizontal plane, and can be brought easily within the plane of a section for tolerably large distances. In our considerations we have not laid so much stress on natural surfaces as on microscopical sections; as in the former the original condition seems to be in great part considerably affected by the process of fossilisation. As we had already occasion to state in the description of the *Monticuliporidæ*, the minute openings of the single cells are very frequently closed on the surface by an accumulation of sparry calcareous matter, which mostly presents a somewhat convex or hemispherical outline, and of which it is up to the present not certain whether it is of organic or inorganic nature, though the latter is more probable. Quite the same peculiarity we find again repeated in the *Stromatoporidæ*. The spaces between the single trabeculæ, which ought to appear as pores on the natural surfaces, are mostly closed by such a secondary deposit, and this is the same in calcareous and silicified specimens.

A peculiarity of the *Stromatoporidæ* that presents a great obstacle to the right interpretation of microscopical sections is the great difficulty experienced in the distinction between the matrix and the different parts of the skeleton, which difficulty originates in the circumstance that the matrix presents in most cases nearly absolutely the same pattern as the trabeculæ of the skeleton, and it depends solely on the mode of preservation, or on the level taken by a section, whether the one or the other is more conspicuous. Even the most acute observers (as for instance Quenstedt) seem to have fallen into errors in this respect, and to have described as skeleton in one section what has been taken to be the matrix in another (compare: Quenstedt, Petref. Deutschl., Vol. IV, part 1, pl. 141, figs. 10-11). There is one character by which the trabeculæ can be unmistakably recognised, which is, however, only rarely preserved, this is their minute structure. Already Baron Rosen has drawn attention to black points within the substance of the different parts of the skeleton of a *Stromatopora*, between which extend very fine dark lines, forming an extremely fine net-work of irregular meshes. Nicholson seems not to have observed these features, and also Bargatzky has only a very incomplete idea of them. As far as can be made out from his figures, he in some cases apparently mistook these dark structural parts, imbedded in the substance of the trabeculæ, for the trabeculæ themselves, and came so to very curious conclusions. Baron Rosen took these things to be the remnants of horny fibres, and therefore considers the *Stromatoporidæ* as horny sponges, whilst Zittel in his Handbook describes cracks within the substance of the skeleton in the section he examined as minute canals, and identifies them with Rosen's horny fibres. We have ourselves found these objects preserved in a beautiful manner in a specimen of *Stromatopora concentrica* from the Eifel, of which we have figured horizontal and vertical sections, Pl. CXX, figs. 4 & 5. The real nature of them did not become quite clear to us. It does not seem that they are canals, as the matrix of the whole specimen is a white calcspar, and there is no reason why just these extremely fine canals should have been filled by a black matrix. It rather appears to us that these lines are parts of the substance of the skeleton, either of a darker colour, or different in density. It is now very remarkable that we have found absolutely the same structure to exist within the substance of the skeleton of a recent *Millepora*, preserved in the Zoological Museum of the University of Prague (Pl. XXI, fig. 4). But in this case also we are unable to state anything particular about the nature of these objects. They appear black and but little granular even with the strongest magnifying powers, and do not appear to be canals. Also in this case it seems to us most probable that they are composed of calcareous matter of a different colour. The remainder of the skeleton is of a finely granular texture. However this may be, even if these lines were produced by boring animals or plants, they are always an unmistakable sign of the parts bearing them being really trabeculæ, or parts of the skeleton (and not of the matrix).

With the aid of this character, we are now in a position to positively assert, in our sections of *Stromatopora concentrica*, what is matrix and what is skeleton. The section, Pl. CXX, fig. 4, extends parallel to the surface of the hydrophyton, and just cuts one of the so-called concentric lamellæ, so that the lamella itself falls within the plane of the section, and we see that the lamella is no real lamella, but that it is composed of variously curved meandering trabeculæ, leaving irregular spaces between them filled by matrix, which again exhibits about the same character as the trabeculæ but forming more isolated spots. If such a section is ground down a very little further, the whole aspect is changed. The spaces which formerly were occupied by the trabeculæ are now taken up by the matrix, and where formerly the matrix was observable the trabeculæ are now found. In other words, whilst within the horizontal layer of trabeculæ (generally taken to be a lamella) the trabeculæ are all continuous, and the matrix occupies separated masses; in the spaces below and above this horizontal layer of trabeculæ the matrix is continuous, and the trabeculæ appear as isolated spots. The picture remains nearly the same, but the substances have changed. It is quite the same in sections vertical to the surface of the hydrophyton. We have figured such a section in Pl. CXX, fig. 5; we must, however, remark that the figure has not been placed in the right position by the artist. The horizontal layers of trabeculæ extend in the direction of the large black spots, placed vertically in the drawing. The section is again placed so that as many elements of the skeleton as possible fall within it. We see the horizontal layers of trabeculæ extend over the whole length of the section only rarely interrupted by ascending canals, filled by white matrix. The so-called interlaminar spaces appear as more or less isolated white spots of matrix. If again this section were ground down a very little, the whole aspect would be changed; the white matrix would then form continuous masses; *i.e.*, the "interlaminar spaces" would appear as continuous horizontal layers, connected together by vertical canals, whilst the trabeculæ, of which the skeleton is composed, would appear as isolated gray spots within the white matrix.

From this it appears beyond doubt that the matrix can assume absolutely the same features as the skeleton, and that it is often almost impossible to distinguish between the two.

As the result of the whole consideration, it follows that the entire skeleton of the *Stromatoporids* is composed of irregularly bending trabeculæ, arranged at intervals in concentric layers, producing in vertical sections the appearance of a framework of square meshes. There is not a trace of compact concentric lamellæ. Now this composition of the skeleton of the *Stromatoporids* by numerous trabeculæ exactly agrees with what we have learnt from Moseley as existing in recent species of *Millepora*, which also consists of concentric layers, though not so distinct as in *Stromatopora*, and each layer is composed of numerous variously bending trabeculæ, leaving between them canals of the same description, occupied by the cœnosarc. The minute structure of these trabeculæ we have found in at least one species of recent *Millepora* to be the same as in the *Stromatoporids*.

What has been said up to the present applies chiefly to those forms of *Stromatoporids* which show a "rectilinear structure," as it has been termed by Carter. The forms that bear "curvilinear structure" are still far more easy to bring into accordance with *Millepora*. The trabeculæ extend in these forms in all directions, and so agree in every respect with what we see to occur in recent *Millepora*. Like the latter, the *Stromatoporids* with curvilinear structure also show an indistinct stratification within the skeleton. The forms with rectilinear and with curvilinear structure are, however, not fundamentally different, as both modes of structure can occur sometimes in one and the same specimen (see our Pl. CXVII, figs. 1 *c*, *d*).

The curvilinear structure can also take an extreme form, when the skeleton appears as a compact calcareous mass without any trace of stratification, and pierced by winding or vermicular canals in all directions (see our Pl. CXVIII, figs. 1 *a*, *d*). But even this mode of structure has its representative in a recent species of *Millepora*, the one figured by Moseley from Zamboangan (Phillipines), of which figure we have given a copy, Pl. CXXI, fig. 3 *c*.

Also *Sporadopora* has a similarly disposed skeleton. (A copy of Mr. Moseley's figure is given in Pl. CXXI, fig. 2.)

After having thus found that there is no fundamental difference in the trabecular structure between the skeleton of the *Stromatoporidæ* and that of the recent *Milleporæ*, we must now direct our attention more particularly to the canals which are occupied by the cœnosarc in recent forms. We can learn only the condition of the cœnosarc in fossil forms by the study of the matrix now occupying the space that was formerly taken up by it.

In the description of the trabecular part of the skeleton, we have seen that there remain between the several trabeculæ free spaces which in general shape exactly resemble the trabeculæ themselves, only that they are often somewhat more slender. These form canals which have served for the reception of the cœnosarc and compose a system of regular or irregular meshes, as the case may be, being exactly similar to what has been figured by Moseley for *Millepora*. At the places where several branches meet, these canals show not rarely slight expansions of a round outline, which might be termed ampulla-like (compare Pl. CXVII, 1 *e, f*). Similar expansions, though perhaps not in the same degree, are to be found in the canal system of the *Stylasteridæ*, as figured plentifully by Moseley, and also to a certain extent in *Millepora*. This tortuous, either reticulate or vermiculate, canal system is common to all forms of *Stromatoporids*, as we have circumscribed the group above, and it shows clearly that all these forms must be more or less closely related to each other. Nevertheless there exist, on the other hand, differences more or less noteworthy between single forms, and these chiefly find expression in the canal-system; as in certain forms at the side of the reticulate or vermiculate minute canals there appear also larger ones which are absent in others. These larger canals, which exist in a great many forms, are of the utmost systematic importance, and require more particular consideration at our hands. The first who recognised the extreme importance of these canals was Carter, whose ingenuity in the definition and comparison of fossil remains with living forms has already often led to discoveries of the utmost interest, and who also in this case hit again on, or very near, the truth. Nobody before him had dreamed of associating the *Stromatoporids* with the *Hydrozoa;* and no sooner had Moseley published his admirable papers on *Millepora* and the *Stylasteridæ* than Carter recognised the near affinity that existed between these forms and the *Stromatoporids*, and gave up his old opinion that the latter were related to the *Hydractinidæ*.

These larger canals, which are to be found in most of the *Stromatoporids*, have very appropriately received from Carter the name of "*Astrorhiza*," and it is to these that we now wish to draw the attention of the reader.

The astrorhiza were first exactly described in a species from the devonian limestone of Dartington to which Carter gave the name of *Stromatopora dartingtonensis*.

The figure accompanying Carter's memoir is very instructive: it shows the astrorhiza to be composed of successive series of radiating branching canals, which unite in successive centres, of which one follows directly above the other, whereby an irregular vertically ascending tube is formed. The radiating canals are not horizontal but sloping, slightly ascending towards the centre of union. Similar canals had been already observed and described by Nicholson and Murie, but these authors state that only in some cases a median, vertically ascending canal is formed. Also Dawson mentions these canals, and affirms that in the centre of the radiating groups they are connected by vertical "tubes or groups of tubes, penetrating the whole mass." Afterwards, however, he falls into the error of bringing these vertically ascending canals into connection with his supposed hollow pillars—a supposition which is absolutely wrong, as in the whole skeleton of a *Stromatoporid* there is no part that is not solid. From all this it appears that vertically ascending canals are by no means of rare occurrence in the *Stromatoporids*, and that these are mostly situated in the centre of astrorhiza. We were able to make the same observation in the materials from the Salt-range, where all the species possess such vertically ascending canals. The radiating canals are in some cases not so distinctly developed in the Salt-range species. Though Mr. Carter on the whole adheres to the opinion that the *Stromatoporids* are allied to the *Milleporæ*, yet he returns off and on to his old opinion of these fossils being *Hydractiniæ*, and thus compares the radiating canals of the astrorhiza to the grooved venation of *Hydractinia*. We think that such a comparison cannot take place, though Bargatzky also advocates it. The grooved venation in *Hydractinia* is occupied by the cœnosarcal stolon tubulation, from which, at the points of division, the different sorts of zooids arise. This stolonal tubulation forms part of the skeleton of *Hydractinia;* it is composed of tubes with compact walls, and the greater part of the cœnosarc is enclosed in these tubes. All this is different in the radial tubes of the *Stromatoporids*. They are tubes without walls, ramify indiscriminately, becoming at the same time thinner and thinner, and are very often at last entirely dissolved in the general tissue of the cœnosarc, which on its part forms winding canals around the different parts of the skeleton, as has been stated above. They form the means of inter-communication between the single zooids projecting from the hydrophyton, and either unite the radiating tubes of adjacent centres directly by their finer ramifications, or by means of the reticulated canals of the general cœnosarc.

If we restrict the term astrorhiza to the single type that has been described by Carter under the name, it would not embrace all the modifications which are presented by similar organs in the *Stromatoporids*. In the forms from the Salt-range there occur two other types, which are not of less importance. There is first a type represented by our new genus *Disjectopora*, having vertical canals connected at intervals by horizontal, not sloping, canals. These latter are not arranged in groups on the same level and thus forming star-like figures, but are placed singly at different levels, and having different directions. The second type, represented by our new genus *Irregulatopora* has, besides the cœnenchymal tubes, large winding canals, of which it is very difficult to decide what are vertical tubes and what lateral canals. Star-like figures are also not produced in this case.

Yet another case seems to occur, which has, however, not been observed by us in nature; it is that of star-like canals without the presence of a vertical canal uniting the successive centres. This seems to be the case in *Strom. astroites* Rosen, according to Bargatzky's indications.

Lastly, in some forms, like *Stromatopora concentrica*, every trace of large canals is absent, and the whole hydrophyton consists of nothing but cœnosarcal tissue.

If we wish to ascertain the nature of the organs represented by the different canals, we can best start from the genus *Disjectopora* mentioned above and represented on our Pl. CXVII, figs. 1*a*—*f*. The vertical section drawn in fig. 1*e* shows in the left hand corner one of the vertical tubes cut longitudinally. About in the middle of its extent we see a kind of tabula, and to the left of it one of the horizontal canals that unite with the vertical tube. Higher up another of the horizontal canals is visible, but here already the vertical tube falls out of the plane of the section. If we now compare this section with the copy of Mr. Moseley's figure of *Millepora*, given on our Pl. CXIX, fig. 4, for comparison's sake, we find almost complete identity. The vertical tube corresponds to the tube of the mouthed zooid in Moseley's figure and the horizontal canals to the "main canals," as they have been called by Moseley; we think then it can no longer be doubted that in general the vertical tubes in the *Stromatoporids* correspond to the abodes of the zooids, and the star-like canals of the astrorhiza to the "main canals" of the *Milleporidæ*. The analogy between our genus *Disjectopora* and the other genera of *Stromatoporids* is very striking. If we take our new genus *Carterina*, figured in Pl. CXVIII, fig. 1, and Pl. CXX, fig. 3, we see on the first of those plates in fig. 1*b* and on the second in fig. 3, one of the astrorhiza as well developed as it can be seen in a section. They are in all respects identical with what we see in *Disjectopora*, with the sole exception that the lateral canals are horizontal in the latter genus and strongly sloping in *Carterina*. It is quite the same in all those *Stromatoporids* which bear astrorhiza, but which show at the same time a regular rectangular framework of trabeculæ, and which have received from Winchell the name of *Cœnostroma*. *Irregulatopora* is somewhat more removed from the general type, as in this form vertical tubes and lateral canals can barely be distinguished. Nevertheless this also belongs to the same type, and the whole number of forms we have mentioned up to the present belong to one compact group, which is as a whole more or less nearly related to *Millepora*, and must thus be considered as forming part of the *Hydrocorallina*.

In all these cases we have not yet spoken of the tabulæ, which are said to exist in the tubes of the zooids of *Millepora*, and which off and on are also observable in fossil forms. We have figured such tabula-like things in *Disjectopora* (Pl. CXVII, fig. 1 *e*) and in *Carterina* (Pl. CXX, fig. 3), but we regret to say that we were convinced that they are generally not tabulæ in the proper sense, but more or less like trabeculæ which cross the cavity of the tube and have fallen by chance within the plane of the section. Nevertheless it is probable that these trabecular structures have served for the same purpose as the tabulæ in the tabulate corals, that is, to shut off the lower part of the living animal from the dead parts of the skeleton. We are not quite certain whether or not in *Millepora* itself the so-called tabulæ are also of a trabecular nature, at least to a certain extent.

In recent species of *Millepora* the living part of the hydrophyton is extremely thin, not more than 0·5mm. If then the zooids at each stage of progress of growth of the hydrophyton were to deposit a tabula behind them, these ought to be extremely numerous. This is however not the case, neither in *Millepora* nor in the fossil forms, so it seems that only exceptionally are such formed.

If we thus consider the vertical tubes of the astrorhiza as the cavities into which the zooids retreated, we must bear in mind that only the uppermost parts of these tubes just below the surface of the hydrophyton were occupied by the living animals, whilst all the remainder of the skeleton was dead.

This goes far towards the explanation of the remaining forms of *Stromatoporids*, in which vertical tubes do not exist.

There are two groups distinguishable among these forms, one with star-shaped canals (*Strom. astroites* Rosen) and one without these canals.

That these forms are most intimately connected with those previously treated of, nobody will deny. They possess absolutely the same trabecular skeleton, only the vertical canals are absent. Thus, it is extremely probable that animals of the same class have built up both sorts of skeleton—in this case animals very nearly related to *Millepora*,—and that the difference between the two classes of *Stromatoporids* consisted solely in the circumstance that in the one group with vertical tubes the single zooids could be retracted within these holes, whilst in the other group, without vertical tubes, the zooids could not be retracted within the skeleton, and were only imbedded in soft tissue at places where groups of cœnosarcal canals united (see Pl. CXXI, fig. 1*b*). From this consideration, however, the extreme systematic importance of the astrorhiza and corresponding organs is obvious. Every one who wishes to sub-divide the *Stromatoporids* into minor groups must start from this cardinal point.

According to what has been said up to the present, the *Stromatoporids* can be divided into two families: the *Cœnostromidæ* with vertical tubes, into which the zooids could retract, and the *Stromatoporidæ*, without such vertical canals, consisting only of a trabecular skeleton.

It is only natural that other observers, starting from other considerations, came to quite different results, and that their systematic arrangement of the different forms must be changed to a certain degree, to fit our sub-divisions. Since Baron Rosen's admirable paper on the structure of the *Stromatoporids*, several classifications have been published, as by Nicholson and Murie, by Bargatzky and by Eugenia Solomko. The first have considered the *Stromatoporids* as calcareous sponges, the second as *Hydractinæ*, and the last as *Pharetrones*.

The first and the last of these opinions are not fundamentally different, as the *Pharetrones* are generally also considered as calcareous sponges of a certain sort. Howsoever this may be, Nicholson and Murie were not very confident in their identification of the *Stromatoporids* with calcareous sponges. They say, p. 231 of their paper in the Linnean Society: "In all the known *Calcispongiæ* the skeleton consists of free spicules, which are never amalgamated or fused with one another, and which, therefore, never form a continuous frame-work, however densely they may be packed together. In no *Stromatoporid*, however, have free calcareous spicules ever been detected by any observer, and the skeleton is undoubtedly a more or less continuous one. If then we were to accept the view that the *Stromatoporidæ* were really referable to the calcareous sponges, we should have to assume that they constitute a special, peculiar group bearing a relation to the typical *Calcispon-*

giæ somewhat similar to that which the *Lithistidæ* or *Hexactinellidæ* of the present day bear to those silicious sponges in which the spicules are not united or soldered together (*Sarcohexactinellida* of Carter, *Lyssakina* of Zittel)." The opinion expressed in these sentences is perfectly sound, so long as the skeleton of the *Stromatoporids* cannot be brought into accordance with any other group of animals without another assumption, but as soon as an affinity can be directly established, Messrs. Nicholson and Murie's assumption must fall, and the similarity between the *Calcispongiæ* and the *Stromatoporids* can only be considered as an apparent one, and not as existing in reality. Now, we have endeavoured to show on the foregoing pages that there exists a real affinity between the *Stromatoporids* and the *Milleporæ*. This affinity is not only supported by similarities in the structure of the skeleton, but also by the discovery of transitional forms between the two groups in the Productus-limestone of the Salt-range. ·

Under the same head falls also Miss Eugenia Solomko's opinion, that the *Stromatoporids* were *Pharetrones*. She also was not in a position to give proof of the existence of calcareous spiculæ in the *Stromatoporidæ*, a character which is essential according to Zittel and Dunikowsky.

More difficult is it to disprove the opinion formerly held by Mr. Carter, and lately accepted by Bargatzky, that the *Stromatoporids* were *Hydractiniæ*, though the difference between the two is in reality very great. The hydrophyton of the *Hydractiniæ* commences with a fine tissue of chitinous tubes, in which the cœnosarc is enclosed. These tubes, or stolons, which can in some cases also be calcareous, are separated from each other by wide spaces; in the *Stromatoporids*, on the contrary, the canals containing the cœnosarc are kept separate by solid calcareous trabeculæ, forming a continuous skeleton just as in the *Milleporids* and *Stylasterids*. Allman's indication that the outer side of the chitinous skeleton of *Hydractinia* was covered by soft naked ectoderm has been refuted by Grobben (Sitzgsber. Wien. Acad. d. W. 1875) in much detail, and he has proved that in the stolonal parts, as well as in the large and small spines, the ectoderm is contained within the chitinous covering; even the interlaminar spaces are probably without cœnosarc. The large and small spines are considered by Grobben as the dwellings of singularly metamorphosed zooids, which have received from him the name of skeleton zooids. All this does not obtain in the *Stromatoporidæ*. If Bargatzky compares the polygonal reticulation, which appears sometimes within the trabeculæ of the *Stromatoporids*, and which we have figured, Pl. CXX, fig. 5 *b*, as equivalent to the polygonal meshes produced by the stolonal tubes of the hydrophyton of *Hydractinia* the error is obvious. In *Stromatopora* this dark reticulation is probably occasioned by differences in structure or colour of the calcareous masses composing the skeleton, perhaps made visible only by secondary processes, and the spaces between the dark parts are filled with the calcareous substance of the skeleton, whilst in *Hydractinia* the stolons are separated from each other by empty spaces, or a fine film of chitinous substance. From all this it appears that the difference of the *Stromatoporids* and the *Hydractiniæ* is very considerable, whilst on the other hand the similarity to the *Milleporids* is striking.

If then the general opinion held by the above-mentioned authors cannot be retained, the sub-divisions of the whole group founded on such erroneous suppositions can only be accepted with great caution; and thus also the genera introduced by Nicholson and Murie, as well as by Bargatzky, can apparently be only partly retained. By Nicholson and Murie the greatest stress is laid on the condition of the reticulated part of the skeleton, whether it is composed of distinct layers or not, &c. We have seen above that the lamination is of minor importance, and that even in one and the same specimen the trabeculæ can be partly arranged in distinct concentric layers, partly not; and thus we cannot accept the distinction as drawn between *Stromotopora* and *Clathrodictyon*. The genus *Pachystroma* we had ourselves occasion to examine closely, as, if we are not much mistaken, the specimen of *Stromatopora concentrica* we have figured in Pl. CXXI, fig. 1, must be considered as belonging to this genus. We have found that the singular structure of *Pachystroma* is simply produced by a peculiar preservation of certain specimens of different species of *Stromatopora*, inasmuch as in such specimens certain zones of the skeleton are either entirely or partly converted into a ferruginous matter, whilst the remainder consists of grey limestone. The transformation has been most complete along the margins of the specimens, and less so in the interior. Thus, in the vicinity of the margins, the small zones separating the calcareous layers from each other consist exclusively of ferruginous matter, which very easily decomposes by weathering; and in consequence of this the lateral surface of such specimens acquires a plaited appearance, as has been figured by us, Pl. CXXI, fig. 1 *a*, or by Nicholson and Murie in the Journal of the Linnæan Society, 1879, Pl. 4, fig. 2. In sections, in these marginal parts of the specimens, these ferruginous zones appear either entirely empty or only occupied by a compact ferruginous layer, so that the thick calcareous parts appear as if not united by vertical pillars. More towards the interior of the hydrophyton, however, the ferruginous layers become less continuous, they are often traversed by calcareous trabeculæ, and one easily recognises that originally the ferruginous layers were of the same structure as the remainder of the skeleton, and that they only have been brought into existence by a secondary transformation of the mineral substance by which the whole hydrophyton was fossilised. Now, it is not absolutely necessary that such transformation should result in a ferruginous substance; other changes may supervene; but in every case, by such chemical processes, the appearance is brought about as if the specimen were composed of thick rather compact calcareous layers, separated from each other by thin laminæ, in which nothing, or very few elements, of the skeleton can be observed, thus giving to the whole the appearance that has been described under the name of *Pachystroma* by Nicholson and Murie. This is distinctly demonstrated by our figures Pl. CXXI, fig. 1 *c*, and Pl. CXX, fig. 5 *a*. Thus, it appears that *Pachystroma* is not a genus of independent value, but must be merged partly into *Cœnostroma* partly into *Stromatopora*.

Another genus created by Nicholson and Murie is ***Stylodictyon***. According to the figures given in the Linnæan Society's Journal, it seems that very different things have been subsumed under the name. The species that has been quoted as type species is rather imperfectly known, as the figures given are drawn on too small a scale to allow of a distinct reproduction of the characters. We think that, so far as can be made out from these drawings, the figures 4 and 5 of ***Stylodictyon columnare*** represent something of which we cannot judge, but which looks very much like ***Labechia***, whilst the other figures, chiefly those of ***Stylodictyon retiforme*** (fig. 1—3, Pl. 3, Journ. Linn. Soc. Zool., Vol. XIV, 1879) point to quite different affinities. In this species appear real concentric plates supported on vertical pillars as in ***Ellipsactinia*** or ***Circopora***, which we shall have to describe later on in the text, and thus this ***Styl. retiforme*** belongs to that group of forms which we have separated above entirely from the ***Stromatoporids*** and which we have designated as perhaps somewhat related to the ***Hydractiniæ***.

Of the remaining two genera of ***Stromatoporids*** emended or described by Nicholson and Murie, ***Stromatocerium*** Hall, and ***Dictyostroma*** Nicholson, we cannot judge, as figures and descriptions are not sufficiently explicit. We shall, however, recur to the latter genus in discussing Solomko's classification of the ***Stromatoporids***.

Only ***Cannopora***, Phillips, with its allies, ***Diapora***, Bargatzky, and ***Parallelopora***, Bargatzky, require yet some notice. F. Roemer has already, some time ago, expressed the opinion that ***Cannopora*** was nothing but a ***Syringopora*** encrusted by a ***Stromatopora***, and Bargatzky's figure of ***Cannopora placenta*** does not quite remove such a suspicion. We had ourselves no occasion to investigate the minute structure either of ***Cannopora*** or of ***Diapora***, and therefore we cannot pass a definite judgment on these things; but if one considers the observations published by Baron Rosen on the incrustation of foreign bodies, and on the power of dissolving these bodies by the animals of the ***Stromatoporæ***, also that the recent ***Milleporæ*** and ***Hydractiniæ*** are encrusting animals that dissolve the calcareous bodies on which they grow, Prof. Ferd. Roemer's opinion gains much in probability. This applies as well to ***Diapora*** as to ***Cannopora***, the difference between the two genera being in fact very small. As regards ***Parallelopora***, Bargatzky, we must confess that we cannot find any difference between Bargatzky's figures and a ***Heliolites***.

The genus ***Stachyodes***, published somewhat later by Bargatzky, might be a ***Stromatoporid***, but the figures are so bad that it is impossible to decide the question. If ***Stachyodes*** represents a ***Stromatoporid***, it then might perhaps be somewhat related to our ***Irregulatopora***.

There remains yet to say a few words on ***Labechia***. This genus has been long since recognised by Lindstroem as not belonging to the corals, with which it had been united by Edwards and Haime. But Lindstroem believed these things to be ***Hydractiniæ***, an opinion which has been refuted by Nicholson on good grounds. A question that appears to us not yet settled beyond doubt with regard to ***Labechia*** is, what, in the thin section figured by Nicholson, is to be regarded as parts of the skeleton, and what as the matrix. If we should judge from the appearances generally presented by thin sections of *Stromatoporids*, we should regard the dark parts as matrix and the light-coloured parts as skeleton, as such distribution of the different colours can very often be observed. The explanation of *Labechia* would then be very simple. The "calcareous columns" were the tubes, in which the zooids were located, and which intercommunicate freely by thin curved canals. The skeleton would consist of thick curved trabeculæ, separated from each other by the canals. That the so-called "calcareous columns" project as blunt spines above the general surface presents no difficulty to such an explanation if one considers the widely spread peculiarity which is of general occurrence in the *Monticuliporidæ*, the *Bryozoa*, etc., that such thin tubes get closed by a secondary deposit of calcspar which mostly protrudes from the tubes as a blunt hemispherical mass. We had not sufficient materials of *Labechia* at our disposal to make sure of this conjecture, but we wish to draw the attention of further observers to this point.

The first attempt at a thorough classification of the *Stromatoporids* was made by Miss Eugenia Solomko (St. Petersburg, 1886), and though she has given no names to the several groups distinguished by her, yet this attempt must be considered as of some importance. As the paper appeared in the Russian language, it will perhaps be gratefully accepted if we give a short sketch of her system before entering into details with regard to it.

She considers the skeleton of the *Stromatoporids* as built up of concentric layers, which are composed of horizontal and vertical rods, and in the most complete development each such layer possesses above and below such a series of horizontal rods, which are united by vertical rods or pillars.

This fundamental type is, however, only rarely to be observed; generally it is more or less stongly modified, and it most frequently occurs that one of the systems of horizontal rods is absent. According to these peculiarities Miss Solomko distinguishes two types:—

TYPE I.

Species with a true stratification of the skeleton, which is brought about by interspaces between the several layers.

1. Group: *DILAMELLATA.*

The layers consist of a series of horizontal rods above and below, connected by vertical pillars; the layers are separated from each other by empty spaces.

2. Group: *MONOLAMELLATA.*

The layers are very dense in consequence of the small development or entire absence of the vertical pillars, whereby the upper and lower systems of horizontal rods unite, forming one compact lamella. The canal system is formed:—

(*a*) either by off-shoots sent out by each layer (*Clathrodictyon*, Nicholson and Murie), or (*b*) by absence of any communication between the single layers, which in their turn are pierced by vertical canals (*Stromatocerium*, Hall, *Pachystroma*, Nicholson and Murie).

TYPE II.

Species with false stratification of the skeleton, formed by interspaces between the vertical rods or pillars. The skeleton consists in reality only of horizontal rods, which bear thickenings at intervals appearing as vertical pillars.

1. Group: (*DICTYOSTROMA*, Nicholson).

The pillars are not united with the horizontal rods above them. According to the distribution of the pillars, several sub-groups can be distinguished:—

(*a*) The pillars are irregularly distributed; thickness of the horizontal rods varies: *Stromatapora dentata.*

(*b*) The pillars are arranged regularly in superposed rows, such forming vertical columns (*Strom. ungerni*, Rosen).

(*c*) The pillars are grouped at certain places, forming double rows (*Stromat. geometrica*, Solomko).

2. GROUP.

The pillars are entirely united with the horizontal rows above:—

(*a*) There are groups of horizontal canals forming star-like figures,

(*b*) Such canals are absent (*Strom. concentrica*, Gdf).

This is the essence of Miss Solomko's classification.

What we most strongly object to in this essay is that the author does not adhere strictly to her own definition of the skeleton of the *Stromatoporids*, as composed of horizontal and vertical rods. We see in her classification suddenly appear the expressions "*Dilamellata* and *Monolamellata*," indicating a return to the old opinion that the skeleton of Stromatoporids was built up of concentric lamellæ. If we stick firmly to the definition that the skeleton consists of a mesh-work of trabeculæ, the true stratification as defined by Solomko becomes a very problematic affair. The inter-spaces between the several layers are then nothing but longitudinal canals within the substance of the horizontal trabeculæ. Even if such canals existed, this would not be of very much importance, as they are decidedly absent in the majority of cases; and when they are present, they must somewhere communicate with the remainder of the cavities containing the cœnosarc. We must, however, confess that Solomko's figure of *Cannopora perforata* does not remove the strong doubts that we have already expressed with regard to the empty interspaces that are said by her to constitute the true stratification of the skeleton. These spaces look in her figure very much like cracks or fractures, and in this respect extremely like the cracks represented in Zittel's woodcut; only that in this case also the vertical pillars have been traversed by them. According to our experience such cracks are very easily produced in grinding down the specimens. But there is yet another cause, which often gives the appearance as if canals were present; this is the peculiarity of preservation which we have observed in a great number of microscopical sections in the *Monticuliporidæ*, as well as in the *Stromatoporidæ*, and which consists in the circumstance that the central parts of the several calcareous elements, of which a skeleton is composed, very often present a different colour from the peripheral parts of the same elements. This has already led Mr. Nicholson to consider his so-called spiniform corallites as open tubes, which they never were, and it may have led Miss Solomko to see canals, where there never were any. At least Mr. Nicholson has not observed these canals in his investigation of *Cannopora perforata*.

If considerable doubts are thus raised as to the real existence of the first group, the *Dilamellata*, this is in a far higher degree the case with the *Monolamellata*. In these Miss Solomko considers the layers of which the skeleton is composed as compact, inasmuch as the upper and lower series of horizontal rods of each layer have been united, and the vertical rods have entirely disappeared. The mesh work, which is nevertheless exhibited by many of these forms, she explains by inflexions of the layers, so that at last one layer is united to the other, as is to be observed, according to her views in *Clathrodictyon*. In other cases these inflexions are entirely absent, and one compact layer follows above the other, without being united, as in *Pachystroma*. Of this latter genus we have shown above that it has probably no real existence, that it is nothing but a modification caused by a singular mode of preservation of *Stromatopora*. Thus, this case of the *Monolamellata* is certainly invalid. But the other case also is highly doubtful, as there exists not the slightest proof that the horizontal trabeculæ in *Clathrodictyon* must be considered as morphologically different from the trabeculæ in *Stromatopora concentrica*, which forms part of Solomko's second type. This distinction then, which is thus introduced into the matter at discretion, is wholly artificial, and not founded in nature.

Thus we see that the so-called "true stratification" of Miss Solomko does not exist in reality, or at least cannot be distinguished from the "false stratification" as it occurs in *Stromatopora concentrica*, and we come to the conclusion that there exists in reality only one mode of stratification in the *Stromatoporids*, which is brought about by the reticulated canals which once contained the cœnosarc.

One point of Solomko's classification is, however, of importance: this is the distinction of the group containing *Dictyostroma*. The forms brought together in the different groups united under the above heading are chiefly *Strom. ungerni* Rosen, *Strom. dentata* Ros., *Strom. geometrica* Solomko, and *Strom. inostranzewi* Solomko.

The first two of these species have been commented on already by Carter, who thinks them to bear an evident similarity to *Hydractinia*, and it cannot be denied that the spines which are in great number distributed on the surface of these species, as well as apparently in large cavities, look very similar to like organs of *Hydractinia* and *Podocoryne*. It must, however, be remarked that in these recent genera the spines are mostly hollow and filled with cœnosarc, and have been considered by Grobben to contain a particular sort of zooid, the skeleton zooids. In the fossil forms, on the contrary, as is evident from Solomko's figures, these spines are solid, and thus the similarity to the spines of *Hydractinia* is only an apparent one.

That all these forms can be comprised in one natural group, which may best receive the name of *Dictyostroma*, Nicholson, is evident. Also their general difference from *Stromatopora* cannot be much doubted, but to say more on the matter is not possible at present. We have had no specimens of this group at our disposal, and can therefore not judge of it; for the moment we place it somewhere in the vicinity of *Stromatopora*.

We have thus seen that the classifications of the group hitherto proposed cannot be applied without precautions. Nicholson and Murie have proposed to form a proper family, the *Stromatoporidæ*, which, on the whole, can be retained though it has been considered by those authors as forming part of the *Calcispongiæ;* but there must be removed from it those forms that are more nearly related to *Millepora* than *Stromatopora* itself. We have demonstrated in the course of our investigations that the forms subsumed by Nicholson and Murie in the family *Stromatoporidæ* must be divided into three parts: first, the genus *Stylodictyon* Nicholson and Murie, which does not comprise any form belonging to the *Hydrocorallina*, and which thus must be altogether eliminated; second, forms in which vertical tubes for the retraction of the zooids do not exist, but in which the whole skeleton is only composed of a more or less reticulated mass of trabeculæ, sometimes traversed by horizontal canals; and, third, forms in which the whole skeleton is traversed by vertical or winding tubes destined for the reception of the animals.

The non-existence of such tubes in certain forms is of the utmost morphological importance; and it appears impossible to leave in one and the same family forms with and without such tubes. We thus cannot but consider the two groups, above indicated as forming two different families.

Thus we arrive at the following classification of the *Hydrocorallina:—*

I. Family: STYLASTERIDÆ, Grey.

Hydrophyton consisting of a cœnosarc composed of reticulated canals, which are separated from each other by a trabecular skeleton, in which large tubes are imbedded for the reception of the zooids. The tubes of the mouthed zooids are nearly always provided with a median columella and mostly show a series of pseudosepta all round. The pseudosepta are generally united by their internal margins, and thus form interseptal loculi. The external appearance of the skeleton is very variable, depending chiefly on the more or less strong development of the trabecular parts of the skeleton in different forms.

Of the genera belonging to this family, only *Stylaster* has been found in a fossil state up to the present.

The genus *Sporadopora*, Moseley, forms to a certain extent a connecting link between the *Stylasteridæ* and the *Milleporidæ*. From the Salt-range we shall have to describe the genus *Carterina*, which can be considered more or less as a connecting link between the *Stylasteridæ* and the *Cænostromidæ*.

II. Family: MILLEPORIDÆ, Moseley.

Hydrophyton composed of an irregular mesh-work of fine canals separated from each other by a trabecular skeleton. Within this trabecular mass, vertical tubes of two sizes are distributed into which the differently shaped zooids can be retracted. The tubes are generally arranged in groups, one larger, surrounded by a number of smaller ones. From these tubes larger canals are sent off in a horizontal direction. Within the tubes a columella and pseudosepta are absent, but they are mostly provided with tabulæ.

The general appearance of the entire hydrosoma is either encrusting or forming flattened branches, mostly with slight elevations or tubercles on which the openings of the tubes for the reception of the mouthed zooids are placed.

Besides the genus *Millepora*, which occurs also in a fossil state in tertiary strata, there are quoted in Zittel's Handbook three other genera as belonging to the family: *Axopora*, E. and H., *Porosphæra*, Steinm., and *Cylindrohyphasma*, Steinm. Of these the first might perhaps belong to the family, the second must certainly be excluded, and the third is a quite problematic thing, the description of which is too short to allow of any conclusion. As far as the macrostructure of the fossil can be judged from the figures, it does not appear quite improbable that it should belong to the *Milleporids*, but the microscopical section figured by Steinmann is so singular, not showing any of the larger tubes in connection with the general tissue of the skeleton, that all comparison with *Millepora* ceases.

III. Family: CŒNOSTROMIDÆ, Waagen and Wentzel.

The calcareous skeleton of the hydrophyton forms polymorphous masses of generally more or less tuberous outline. Surface of the hydrophyton wavy or covered with little tubercles, and strewn with small apertures, which are mostly distributed irregularly and only sometimes united into little groups. They form the entrances to vertical tubes, into which the zooids were able to retract. These vertical tubes inter-communicate either directly by mostly sloping or horizontal canals, the branches of the astrorhiza, or this communication is not direct, inasmuch as between the astrorhiza of adjacent centres a mesh-work of fine canals is intercalated. Sometimes the communication between the vertical tubes is entirely taken up by these small winding or reticulated canals, which traverse the entire trabecular skeleton. The vertical tubes, and even exceptionally the lateral canals show sometimes trabecular tabulæ. The whole mass of the skeleton is made up of solid, anastomosing, calcareous trabeculæ, which are either arranged in parallel zones, so that in vertical sections a rectangular mesh-work appears, or the trabeculæ extend irregularly in all directions, whereby the mesh-work becomes also irregular.

The trabeculæ contain black-coloured, polygonal, intersecting calcareous fibres, which are mostly thickened at the points of intersection, or they possess a simply granular structure. The cœnosarc forms in general a net-work of fine canals, which at the points of intersection show mostly ampulla-like dilatations.

On the whole, this family is very nearly related to the preceding one, and for long we were much in doubt whether it was altogether possible to distinguish it from the *Milleporidæ*. The reasons which led us at last to the distinction are the following:—

1. The absence of a distinct grouping of the tubes of the zooids.
2. The absence of a difference in size between the tubes of the mouthed and those of the mouthless zooids.
3. The arrangement of the trabeculæ in a regular quadrangular framework.
4. The very characteristic fashion in which the radiating canals are distributed round the vertical tubes of zooids.

All these points together seemed sufficient to distinguish the group of the *Cœnostromidæ*, as a proper family, from the *Milleporidæ*.

Which of the genera hitherto described may belong to the family is rather difficult to indicate, as just the most important characters have been generally neglected in the distinction of genera up to the present. The most typical form of the family is, as far as we can make out, apparently represented by the genus *Cœnostroma* Winchell. It is however very much to be regretted that the papers in which Winchell has established the genus are apparently very rare, so we also were as little in a position to examine their contents personally as Nicholson and Murie had been. As, however, it is known that the genus has been founded on the presence of astrorhiza, that is of star-shaped canals on the surface, and that, if such occur, they generally are connected by a central tube, we consider the genus *Cœnostroma* to comprise such of the *Stromatoporids* as possess vertical tubes into which the zooids were able to retract, surrounded by sloping radial canals. These characters are most strikingly developed in *Stromatopora dartingtonensis* Carter, and therefore we should like to introduce this one as the typical species.

The genus *Cœnostroma* has generally been considered identical with *Stromatopora*, and it apparently is so, if one takes *Stromatopora polymorpha* Gdf., to be the type. Against this, however, there can be adduced that *Strom. polymorpha* is a true *mixtum compositum* of different forms (Bargatzky has shown that there were not less than five different species comprised under the name), and that in reality it is *Strom. concentrica* Gdf., which must be considered typical of the genus *Stromatopora*. Not only that *Strom. concentrica* is figured on an earlier plate (VIII) of Goldfuss's works than *Strom. polymorpha* (which is figured on Pl. LXIV), but also the first figure, fig. 8 *a*, of the latter, which ought to retain the name "polymorpha" if the other figures are recognised to represent other species, is identical with *Strom. concentrica*, so that there is no escape but to take *Strom. concentrica* as the typical species of the genus *Stromatopora*. Now, it is well known that this latter species possesses no astrorhiza, and thus it is evident that the name *Stromatopora* must be applied to forms without such. So we must distinguish generically between *Cœnostroma* and *Stromatopora*.

We thus have as the first genus of the family to quote—

1. Cœnostroma, Winchell, 1866: Proceedings, American Association;—Nicholson and Murie: Jour. Linn. Society, Zoology, Vol. XIV, 1879, pp. 191, 217.—Hydrophyton polymorphous; the skeleton composed of trabeculæ forming mostly a rectangular mesh-work, and being arranged more or less distinctly in concentric layers. Surface generally provided with tubercles, on which mostly the centres of the astrorhiza are situated. In these centres vertical tubes open, into which the zooids were able to retract. Typical species, *Cœnostroma dartingtonense* Carter, sp.

The genus seems to be restricted to upper-silurian and devonian strata.

It is doubtful whether those species which show several vertical tubes grouped together, like *Strom. polyostiolata* Bargatzky, or *Strom. typica* Rosen, ought not to be considered as generally different.

2. Carterina, Waagen and Wentzel, n. gen.—Hydrophyton reversed conical; skeleton composed of trabeculæ, forming a quite irregular mesh-work, showing no stratification whatever. Tubes for the retraction of the zooids numerous, irregularly bending, provided with trabecular pseudosepta, and thus in transverse section mostly star-shaped; lateral canals very strongly sloping, about of the same width and the same description as the principal tubes, arranged radially round the latter; trabecular tabulæ, of very rare occurrence.

Typical species: *Carterina pyramidata* Waagen and Wentzel, n. sp. The genus has been found up to the present exclusively in the Productus-limestone of the Salt-range.

By the existence of pseudosepta though in a trabecular form, the present genus recalls to a certain extent the characters of the family *Stylasteridæ*.

3. Disjectopora, Waagen and Wentzel, n. gen.—Hydrophyton reversed conical; skeleton composed of trabeculæ which form a tolerably regular, rectangular mesh-work and are arranged in concentric layers. Tubes for the retraction of the zooids rather far distant from each other, tolerably straight, sometimes provided with tabulæ; lateral canals generally narrower than the main tubes, horizontal not sloping, radiating singly at different levels.

Typical species: *Disjectopora milleporæformis* Waagen and Wentzel, n. sp.

The genus is restricted to the Productus-limestone of the Salt-range.

In general arrangement of the several parts the present genus comes very near *Millepora*.

4. Irregulatopora, Waagen and Wentzel, n. gen.—Hydrophyton lamellar or flatly conical; skeleton composed of irregularly arranged trabeculæ, forming an irregular mesh-work; no stratification; tubes for the retraction of the zooids very irregularly bending and barely distinguishable from the lateral canals, which probably also exist. Trabecular tabulæ sometimes present.

Typical species: *Irregulatopora undulata* Waagen and Wentzel, n. sp.

The genus has been found up to the present only in the Productus-limestone of the Salt-range.

These are the forms we can assign for the present with certainty to the family. We regret to say that we are unable to introduce any of the generic names applied by Nicholson and Murie. We have already stated our reasons in this respect. The only genus which is certainly a distinct one, ***Dictyostroma***, belongs to the next family. On ***Cannopora***, ***Diapora***, and ***Stachyodes*** we cannot judge, having not studied them in nature. If their structure is a feature belonging originally to them, then they must be placed in the present family.

IV. Family: *STROMATOPORIDÆ.*

The calcareous skeleton of the hydrophyton forms polymorphous masses of a partly laminar, partly tuberous outline. It consists of solid trabeculæ, which are mostly arranged in regular concentric layers, and form thus a framework of rectangular meshes; sometimes, however, they are also arranged irregularly. The trabeculæ are sometimes swollen at the points of intersection, and sometimes their horizontal branches send out processes which do not reach the next following horizontal layer. Between the trabeculæ extend canals of the same appearance as the trabeculæ, which either form also a rectangular network, and then at the points of intersection they are often widened, or they are vermiculate and very irregular. Larger radiating canals, which are not in connection with vertical tubes, are present in some forms. The zooids were either placed at the centres of these radiating canals, or, where these are absent, at places where a greater number of the canals of the cœnosarc come together (Pl. CXXI, fig. 1 *b*). These are then also arranged in a more or less radiating manner. There were no openings for the retraction of the zooids within the skeleton.

The intimate structure of the trabeculæ is as in *Cœnostroma:* they contain fibres of a dark calcareous mass, forming a network and being swollen at the points of intersection, or the whole mass of the trabeculæ is simply finely granular.

The genera belonging to this family are not numerous, though it is probable that they can be augmented considerably. At present we can distinguish the following genera:—

1. STROMATOPORA, Goldf., 1826: Petref. Germ. I., p. 13, Pl. VIII, f. 5.—The hydrophyton attaining considerable dimensions, mostly tuberous in shape; trabeculæ forming a more or less regular network, where a distinct stratification of the skeleton is attained; radial canals are absent.

Typical species: ***Strom. concentrica*** Goldf.

The genus seems of an exclusively devonian distribution.

2. ROSENIA, Waagen and Wentzel, n. gen.—We introduce this name for those forms which are, like ***Stromatopora***, devoid of vertical tubes, but which at the same time possess radiating canals. The skeleton is generally composed of a regular network of trabeculæ.

Typical species: ***Rosenia astroites*** Rosen, sp. (Bargatzky: Verh. d. naturhist. Vereins d. Preuss. Rheinl. u. Westph., 1881, p. 284).

The genus seems to occur in silurian and devonian strata.

3. POROSPHÆRA, Steinmann, 1878: Palæontographica, Vol. XXV, p. 120, Pl. XIII, fig. 812.—Hydrophyton sphæroidal, never very large. Trabeculæ of the skeleton forming a very irregular network, a stratification of the skeleton is not observable. Sometimes, but not always, there appear radiating canals.

Typical species: *Porosphæra globularis* Phill., sp.

The genus is restricted to cretaceous beds.

It is somewhat doubtful whether this genus is rightly placed here, but for the moment the present position seems the most probable one.

4. DICTYOSTROMA, Nicholson, 1875: Palæont. of Ohio, Vol. II, p. 254.—This genus represents a rather far deviating type, in which the trabecular parts of the skeleton have experienced a strange modification. There is chiefly the horizontal part of the trabeculæ developed, whilst the vertical extensions are transformed into thick protuberances, which only partly unite with the following horizontal layer. Vertical tubes for the reception of the zooids are absent.

Typical species: *Dictyostroma undulatum* Nich. (other species: *Dictyostr. ungerni* Rosen, *dentatum* Rosen, etc.).

The chief distribution of the genus seems to be in upper silurian strata.

With this genus the number of generic types we can at present assign to the family is at an end.

Of all these genera and families only one family, the *Cœnostromidæ*, is represented in the Salt-range. Three of the genera we were able to quote in this family have up to the present been exclusively found in the Salt-range, and they are of special interest as transitional forms between the old *Cœnostromids* and the recent *Milleporids*. It was mainly this intermediate position that led us to a right understanding of the *Stromatoporids* at large, and we could not abstain from exposing the results of our studies on the other forms in this place, as they bore also on the position of the Salt-range forms. This intermediate position, however, is also in accordance with the geological position of the beds in which these things occur, and constitutes a highly interesting instance of the degree of accuracy with which one can judge on the age of a bed by the analogy of its organic contents with geologically older and more recent forms of life.

Genus: CARTERINA, Waagen & Wentzel, n. gen.

We can be brief in the description of the genera, as well as of the species, as the most important points of the organisation of these forms have been already mentioned above.

In this genus the hydrophyton is massive and of considerable dimensions. It is composed of trabeculæ which form a very irregular network, leaving winding, more or less vermicular, canals between them, in which the cœnosarc was contained. A regular, more or less rectangular network, as is observable in many of the other genera of *Cœnostromids*, does not occur in this genus. The canals sometimes show irregular widenings, a sort of lacunæ, as also sometimes exist within the skeleton of *Sporadopora*, a genus of the *Stylasterids*.

This trabecular skeleton is traversed in all directions by larger tubes, which show a characteristic arrangement. There is, as in *Cœnostroma darlingtonense*, a central tube, which we consider as the dwelling-place of the mouthed zooids. This central tube is surrounded by a number of sloping radial canals of nearly the same width as the central tube, which in an irregular way approach more and more the latter, and at last unite with it from opposite directions at the same time. This takes place repeatedly at different levels.

The central tubes, as well as the radiating canals, are often traversed by trabeculæ, which are either single or gathered in groups, and which perhaps have had the functions of tabulæ.

The central tubes, and perhaps also the radiating canals, are provided with a small number of trabecular pseudosepta, which give to the transverse section of these tubes, in the plane of the pseudosepta, a singular star-shaped appearance.

The present genus is very nearly related to *Cœnostroma* Winchell. It has the same distribution of the calices, or central tubes, with regard to the radiating canals, but the trabecular skeleton is more irregular, the canals of the cœnosarc often form small lacunæ as in *Sporadopora*, and the calices possess distinct trabecular pseudosepta, all characters which do not occur in *Cœnostroma* and which make absolutely necessary a generic distinction between these and the Indian fossils.

It has been remarked already above that the present genus possesses certain characters which approach it more or less to the *Stylasteridæ*. These characters are the existence of pseudosepta and the extreme irregularity of the trabecular skeleton, which on the whole more resembles that of *Sporadopora* than that of *Millepora*. But though we cannot deny these facts, yet we think it improbable that *Carterina* should be united with the *Stylasteridæ* instead of with the *Cœnostromidæ*, as just the most important point of its organisation, the distribution of the larger tubes and canals, is so absolutely identical with that occurring in *Cœnostroma* that the real affinity with the latter genus cannot be mistaken, and its position in the *Cœnostromidæ* becomes absolutely necessary.

The genus is represented in the Salt-range by a single species—*Carterina pyramidata*. From other localities the genus has as yet not been reported.

1. CARTERINA PYRAMIDATA, Waagen and Wentzel, n. gen. et sp., Pl. CXVII, fig. 2, Pl. CXVIII, fig. 1, and Pl. CXX, fig. 3.

The general form of the hydrophyton is massive and apparently reversedly conical, though we are not quite certain what the natural position of the specimen may have been. We place it so that the pointed end of the conical mass is below, and we believe that it was fastened by this end to the bottom of the sea. The reversedly conical shape is, however, very irregular, the apex being bent to one side.

The natural surface seems to be nowhere quite intact, being everywhere deteriorated by weathering. As it is, the surface is strongly undulating and even lamellose on the lateral parts of the conical mass, and is entirely covered up by rock matter at the base of the cone, where however the specimen is terminated by a fracture, and not by the natural surface. The wrinkles on the lateral faces are approximately concentrically arranged round the apex.

If examined with a very strong lens, or with low magnifying powers of the microscope, the surface appears partly covered with round star-like openings, partly with winding canals, both different aspects of the calices, or tubes, into which the zooids were able to retract. These tubes open for the most part on the upper fracture of the specimen, but on account of their irregular bending some also open on the lateral surfaces, and are then also seen sideways on the upper fracture.

These calices are quite irregularly distributed and are never arranged in anything like regular groups, as is the case in the recent *Milleporæ.*

The most peculiar feature of these tubes is the existence of trabecular pseudosepta, which give to the whole a quite singular appearance. They are mostly to the number of seven to eight all round the tubes and bear a little thickened point at their terminations. They are rather regularly distributed in the vertical, as well as in the horizontal direction, and united together all along the outer limits of the tubes by trabecular parts of the skeleton. The spaces left between them are, however, rather large, and thus in microscopical section it mostly happens that not the pseudosepta, but the spaces between, are cut.

We have given on Pl. CXVIII figures both by reflected and by transmitted light. It must, however, be remarked that the colouring of the different parts is just the reverse in the different modes of light: what appears white in reflected light is all black in transmitted light, and *vice versâ.* This must be well remembered for the right understanding of our figures.

Fig. 1 *a* is a part of the upper fracture of the specimen as seen in reflected light. A little below the centre of the figure one sees several of the calices cut transversely and exhibiting very clearly the pseudosepta. Towards the margin of the figure several of the tubes are cut longitudinally, and one sees distinctly that one central tube is surrounded by several sloping ones. The large hole filled with grey matrix is either the work of some boring animal, or perhaps corresponds also to the "cavity or ampulla of a male gonophore," as occurs in the recent *Sporadopora,* as figured by Moseley, a copy of which figure we have given, Pl. CXXI, fig. 2. Fig. 1 *d* is a part of the lateral surface, also seen in reflected light, showing several tubes cut longitudinally. In both these figures the trabecular parts of the skeleton appear black, whilst the matrix filling the spaces between the trabeculæ and occupying the place of the cœnosarc shows a whitish colour.

Figs. 1 *b* and *c* are microscopical sections as seen by transmitted light. One represents a transversal, the other a longitudinal section. In both, the pseudosepta do not fall within the plane of the section. The trabecular parts of the skeleton are white, whilst the matrix appears black or grey and granular. None of the calices is cut quite straightly across, but in fig. 1 *b* at the left hand upper corner, a central and two sloping tubes are seen very distinctly on the point of uniting. The same is seen in Fig. 3, Pl. CXX, a microscopical section in transmitted light showing a central tube cut obliquely and three of the radiating canals uniting with it. In all these sections drawn by transmitted light, the quite black round spots indicate cœnosarcal canals cut transversely by the plane of the section.

If very strong magnifying powers are employed, the substance of the trabeculæ appears as if intersected in all directions by dark lines. Traces of these can be seen in different places on our figures. We have satisfied ourselves that these lines are nothing but fine cracks, produced in the preparation of the sections within the sparry substance of the trabeculæ.

The measurements are as follow:—

Height of the hydrophyton so far as preserved, about	80·0 mm.
Greatest transverse diameter	85·0 „
Width of the vertical tubes	0·25— 0·3 „
„ radial canals	0·2 — 0·25 „
Diameter of the cœnosarcal canals	0·03— 0·1 „
„ „ ampulla-like enlargements	0·07— 0·13 „

Locality and geological position.—The only specimen of this species preserved in the Salt-range collection was found in the middle Productus-limestone of Chidru.

Remarks.—The fossil that has been described by us here under the name of *Carterina pyramidata* shows so very singular characters that it is barely possible to compare it to any other form described up to the present. There are some things bearing a distant similarity, but this is certainly only superficial and does not imply a real affinity of them to our species. There is, for instance, *Heliolites dubia*, Fr. Schmidt, from silurian strata, as figured by Dybowsky, which on a first glance seems to be somewhat similar to the Indian fossil, as also in this species the pseudosepta are of a trabecular nature, rather far distant from each other and separated by intervals of a rounded outline, and also bearing a rounded knob at their terminations, so that in transverse sections the tubes of this *Heliolites* look nearly identical with the calices of our *Carterina pyramidata*. But on a closer examination one finds that the walls of the tubes of that *Heliolites* are solid, and that there exists no trabecular skeleton, so all comparison ceases.

To similar results one comes also in other cases, and one must admit that *Carterina pyramidata* is a quite singular fossil which bears only family similarities to the *Cœnostromidæ.*

Genus: DISJECTOPORA, Waagen and Wentzel, n. gen.

Hydrophyton massive, of not very large dimensions, composed of trabeculæ, which partly form a regular network, partly are irregularly arranged. At the points of intersection they are thickened, and on the surface these thickenings often project as little knobs. If a regular network prevails, the horizontal trabeculæ form distinct zones, whereby a concentric lamination of the whole skeleton is produced. Between these trabeculæ canals extend, which also either form a regular network of the same description as that produced by the trabeculæ, or are irregular according to the distribution of the trabecular mass. These canals show ampulla-like widenings at the points of intersection and are on the whole of a roundish outline; in the living state they contained the cœnosarc.

In this network composed of trabeculæ and the intervening canals, larger tubes are imbedded which served for the reception of the zooids. They are tolerably straight, not very strongly bending, arranged very irregularly and not numerous. Their width is about twice that of the cœnosarcal canals. At intervals these tubes send off horizontal canals in radial directions, but at different levels; they are not much narrower than the tubes themselves. It cannot be made out whether the canals belonging to one tube directly unite with the other adjacent vertical tubes, or whether a communication is only effected by means of the cœnosarcal canals.

The vertical tubes are in their transverse section rather irregular, not round, and change readily in shape, as the cœnosarcal canals open into them from different directions. At intervals the tubes are traversed by tabulæ which are apparently not quite of a trabecular nature, but somewhat more solid.

From this description it appears that the present genus is rather nearly related to the living *Millepora*, and in fact the relation is so very close that we for a long time were in doubt whether we should not regard the present form as directly forming part of that genus. The chief similarities consist in the vertical tubes being provided with distinct tabulæ, and sending off horizontal canals at different levels; these however do not merge directly into the tubes in *Millepora*, as they do in the present form. Though these similarities exist, we have yet decided not to place the present form too closely near *Millepora*, but to remove it even altogether from the family and to put it in the *Cœnostromidæ*. The reasons for thus proceeding are, that the tubes of *Disjectopora* are not arranged in groups; that there exists no difference in size between the tubes containing the mouthed and those destined for the reception of the mouthless zooids; and, lastly, the conditions of the trabecular skeleton, which forms for the most part a regular network, as generally occurs in the fossils hitherto considered as forming the family of the *Stromatoporids*, and not a network exactly similar to that occurring in the recent *Milleporæ*. These peculiarities seemed to us sufficient to indicate a systematic position of the fossils totally different from the *Milleporids*, whilst they all are such as generally occur in the fossils belonging to the family *Cœnostromidæ*; we accordingly felt justified in considering the genus *Disjectopora* as forming part of that family.

In the Salt-range the genus is represented by a single species, *Disjectopora milleporæformis*. As far as is as yet known, the genus has not been observed to occur at any other locality.

1. DISJECTOPORA MILLEPORÆFORMIS, Waagen and Wentzel, n. gen. et sp., Pl. CXVII, fig. 1.

The hydrophyton forms apparently a reversedly conical mass of not very large dimensions. It is, however, difficult to decide what may have been the original position of the fossil, as the broad part of the cone is occupied by a plane of fracture, and the calices which served for the reception of the zooids open also everywhere on the lateral faces of the cone. Nevertheless it has somewhat the appearance as if the blunt apex of the cone bore something like a place of insertion, by which the whole hydrophyton was attached to a foreign body, and therefore we consider that the apex was below, and the broad part of the cone above.

The natural surface of the specimen is partly well preserved on the lateral faces, whilst it has entirely disappeared at the upper termination. As far as the surface is preserved, it shows a more or less regular network of trabeculæ interrupted from time to time by a compact epidermal tissue, of which it is, however, not quite certain whether it is an original feature, or of a secondary origin produced by the process of fossilisation (Pl. CXVII, fig. 1 *c*). The trabeculæ themselves have somewhat suffered by the process of weathering at the surface, and consequently appear there much thinner in general than they do in the interior of the specimen when seen in microscopical sections. We have figured in Pl. CXVII two different parts of the surface. One of them shows a rather regular net-work, in which horizontal and vertical branches of the trabeculæ can be clearly distinguished, whilst the other shows a quite irregular net-work, where such a distinction is impossible. In both pictures, chiefly in the latter one, numbers of calices are distributed; but on account of the alteration the surface has suffered by the process of weathering, the distinction is rather difficult. We consider the larger of the holes circumscribed by the trabeculæ as calices, that is, as entrances to the tubes into which the zooids were able to retreat. These calices are in these cases but little distinct from the remainder of the cœnosarcal tissue; in microscopical sections, however, where the tissue has not been altered, the distinctness is easily traceable (Pl. CXVII, fig. 1 *f*).

The trabeculæ thus exposed at the surface show several peculiarities. First we see that at the points of intersection, where several branches of the trabeculæ meet, they are considerably swollen; partly there even appear at these places small prominent knobs or obtuse spines (Pl. CXVII, fig. 1 *d*). In the same figure we also see that of the trabeculæ which radiate from the points of intersection in all directions, all the branches are not joined to other branches of an opposite direction, some remain free and extend within the meshes of the trabecular net-work.

In microscopical sections, of which we have made several, the trabecular part of the skeleton shows two peculiarities; first, that the central parts of the single trabeculæ are often differently coloured from the peripheral parts, and second that often a strange mode of preservation obtains, which either altogether obliterates the trabeculæ or at least changes them considerably in aspect.

As regards the first of these peculiarities, this very often gives the impression as if the trabeculæ were hollow, and traversed in the centre by a fine canal. After comparison of many sections, and after much painstaking, we arrived with perfect certainty at the conclusion that the trabeculæ were never hollow, and that this appearance was brought about by exactly the same circumstances as have been observed by us on a large scale in the Monticuliporidæ, where the walls of the single corallites also seemed often as if traversed by a longitudinal canal, whilst this appearance was solely brought about by a singular mode of preservation. We are in consequence of this absolutely certain that hollow trabeculæ never occur.

The second peculiarity does not influence the description of the species, and therefore will be treated of later on.

The large tubes with their horizontal radiating canals have been described already above in the description of the genus. Their distribution is extremely irregular, as can be seen in Figs. 1 *e* and 1 *f*, Pl. CXVII. On the whole, it appears that their direction is approximately vertical in the centre of the specimen, and slowly bending laterally in the vicinity of the periphery. The tabulæ are not numerous, but apparently of a more compact nature than in other allied forms.

The measurements are as follow :—

Height of the hydrophyton as far as preserved	50·0 mm.
Greatest transverse diameter	58·0 „
Width of the vertical tubes	0·25— 0·33 „
„ „ radial canals	0·2 — 0·25 „
Diameter of the cœnosarcal canals	0·1 „
„ „ ampulla-like enlargements	0·1 — 0·13 „
„ „ trabeculæ	0·1 „

Locality and geological position.—There is a single specimen of this species in the Salt-range collection; it was found by Mr. Wynne in the middle Productus-limestone of Morah.

Remarks.—The specimen here under description shows a very peculiar preservation, inasmuch as its real structure is visible only at certain places; at other places, on the contrary, the real structure has been entirely obliterated and has given place to a kind of mock structure which might very easily be misleading. In fig. 1 *e*, Pl. CXVII, we see at both ends and in the middle of the figure certain places in which not a trace of trabeculæ can be made out, but where only meandering black lines can be distinguished. Such a spot has been represented, more strongly magnified, in Fig 1 *g*. One sees in this figure that here the skeleton has been transformed into one compact calcareous mass in which ferruginous parts, probably occasioned by the presence of the organic matter, have been secreted. These secretions may once have had some relation to the distribution of the solid skeleton; but as they appear now such a relation can no longer be made out, and thus we have a quite irregular distribution of ferruginous particles, partly grouped together in meandering lines, partly in isolated spots which allow of no conclusion as to the original condition of the fossil. Had the whole mass of the specimen been subject to a similar process of transformation as we see appear now in certain isolated places, a proper determination of the fossil would have been absolutely impossible.

The first beginning of this mode of preservation is represented by the dark lines, traversing the substance of the trabeculæ in different parts of the same figure (1 *e*) and giving somewhat the impression of dark canals.

The species is most nearly related to *Millepora alcicornis* of our present seas, but we have stated already above why it should neither be considered as forming part of the genus nor of the family. To other forms, recent or fossil, the present species is much less nearly related, and we know of none to which it could be more closely compared.

Genus: IRREGULATOPORA, Waagen and Wentzel, n. gen.

Hydrophyton massive or lamellar, composed of a finely trabecular skeleton, in which larger tubes, some vertical, some horizontal, are imbedded.

The trabecular part of the skeleton is very irregular, the trabeculæ themselves very thin, and the canals between so much the larger. Neither the trabeculæ nor the cœnosarcal canals form a regular network, both being quite irregularly distributed. The canals very often show ampulla-like widenings at the points of intersection.

A concentric lamination or stratification is also absent.

The larger tubes, which have served for the reception of the zooids, are also very irregularly distributed. They are three to four times as wide as the cœnosarcal canals, and open everywhere on the surface of the hydrophyton. They are sometimes traversed by trabeculæ which are either single or in groups, and have probably the functions of tabulæ. The transverse section of these tubes is also very irregular; they are only very indistinctly marked off from the cœnosarcal tissue. On the whole they are more or less round, but in the single microscopical transverse section this round shape is more or less obliterated by the numerous cœnosarcal canals which enter the tube from all sides, and are not distinctly marked off from the tubes, properly speaking.

Between these vertical tubes, that served for the reception of the zooids, there extend irregularly horizontal tortuous canals of about the same width as the tubes, not traceable to any of the vertical tubes, but winding between them to and fro, and being in connection with the tubes solely by the cœnosarcal canals. In this respect they remind one much of the similar canals that have been figured of *Millepora* by Moseley, which figure we have copied for comparison's sake on Pl. CXXI, fig. 3 *a*. The whole arrangement is only much more irregular in *Irregulatopora* than in *Millepora*. These tubes can be seen in our fig. 2 *c*, Pl. CXVIII at different places. They are, however, exposed only for short distances within the section there figured, as they bend in the horizontal direction, and thus fall only for short distances within the plane of a section.

From this description it appears that the present genus is about as nearly related to *Millepora* as to the preceding one, or perhaps still more closely. This is chiefly expressed in the distribution of the horizontal canals, which are isolated, not merging directly into the vertical tubes, but connected with them only by means of cœnosarcal canals; they are not arranged in any way radially round the tubes. This arrangement of the horizontal canals is almost exactly as in *Millepora nodosa*, only that it is far more irregular in the present genus, and consequently a distinction between the horizontal canals and the vertical tubes is much more difficult.

Though, thus, in this respect the relation between *Irregulatopora* and *Millepora* is very close, there are on the other hand considerable discrepancies.

In the first place, these so-called horizontal canals are not, properly speaking, horizontal. They do not extend approximately in one plane, as is the case in *Millepora*, but bend irregularly up and down. While thus by these canals in *Millepora* an indistinct concentric stratification of the skeleton is produced, not a trace of such stratification can be observed in the present genus. The trabecular skeleton is far more irregular than in *Millepora*, and thus the whole forms a porous mass of very irregular tissue. In the tubes of *Millepora* rather compact tabulæ are developed, whilst in *Irregulatopora* these are replaced by trabeculæ, either singly or in groups.

Thus we see that in the present genus great similarities to *Millepora* go hand in hand with as great discrepancies. Notwithstanding this near affinity to *Millepora*, we have decided on placing the present genus in the family *Cœnostromidæ* rather than in the *Milleporidæ*, chiefly on the grounds of analogy with other forms, especially with *Disjectopora*.

The points of discrepancy between *Irregulatopora* and the *Milleporidæ* consist chiefly in the arrangement of the calices, which are not placed in groups; in the absence of a difference in size between the calices of the mouthed and mouthless zooids; and in a greater irregularity in the arrangement of all the parts of the hydrophyton.

Among the *Cœnostromidæ* the present genus forms certainly the most strongly deviating type.

Of the forms belonging to this latter family, the genus *Disjectopora* described above, is most nearly related to the present genus. The differences between *Irregulatopora* and *Disjectopora* are, however, rather obvious. The skeleton, which forms a tolerably regular network in *Disjectopora*, is quite irregular in *Irregulatopora*. The tubes for the reception of the zooids are irregular in their arrangement, as well as in their direction, and are apparently not in direct connection with the horizontal canals, which are at the same time very large and irregularly bending in the latter genus, whilst all this is not the case in the former. So it seems that the two genera are easily distinguishable from each other, whilst their affinity on the other hand is so great, that both must very likely be placed in one and the same family.

The genus has been found up to the present only in the Salt-range, and is there represented by a single species, for which we introduce the name *Irregulatopora undulata*.

1. IRREGULATOPORA UNDULATA, Waagen & Wentzel, n. gen. et sp., Pl. CXVIII, fig. 2.

Hydrophyton lamellar, or somewhat irregularly cup-shaped. Upper surface alone exposed, undulating but otherwise smooth, not rugged as in the two preceding genera and species, finely porous. The calices can only be distinguished with difficulty; they are strewn all over the surface, but very irregularly distributed. The trabecular skeleton only distinguishable with a powerful lens, very irregular, showing nowhere any attempt at forming a regular network.

The dimensions of the hydrophyton are rather considerable.

The real structure of the specimen can only be recognised in microscopical sections. One can then observe that the substance of the hydrophyton is built up of a trabecular skeleton, in which the substance of the several trabeculæ is rather irregular in thickness, but generally comparatively thin. They leave room between them for canals, which are considerably thicker than the trabeculæ and which are chiefly characterised by round ampulla-like widenings occurring at all points where several branches of these canals meet. In these canals the cœnosarc was enclosed. They are altogether vermicular in their arrangement.

In this trabecular skeleton two sorts of larger tubes are inserted, but are only distinguishable with difficulty. The most important of these are the so-called vertical tubes, which open as calices on the surface of the specimen. These are best seen in the vertical section, represented Pl. CXVIII, fig. 2 *d*, where they are cut longitudinally. Some of them are nearly straight, others bending very irregularly; the preservation of the specimen is, however, not sufficiently good to follow them for any greater extent. They are often, and very irregularly, traversed by trabeculæ. In fig. 2 *c*, which is a horizontal section, parallel to the surface, several of these tubes are cut transversely. Also here they appear very irregular in every respect. Some of them appear larger, some narrower, some of them are more oval, others more circular, all are very indistinctly circumscribed, because of the circumstance that so many of the cœnosarcal canals open into them that the outline of the tubes themselves is nearly obliterated. Another cause of this indistinctness are the several trabeculæ which traverse the tubes obliquely, and thus happen sometimes to be cut transversely just in the middle of the tubes.

In the same figure there appear between the more roundish tubes, cut transversely, strongly elongate winding black bands, representing the so-called horizontal canals. These also are very indistinctly defined, as countless cœnosarcal canals open into them. We see that these canals are nowhere in direct communication with the tubes, but are joined to them only by the narrow cœnosarcal canals.

The measurements are as follow :—

Greatest length of the lamellar hydrophyton	52·0	mm.
„ breadth	46·0	„
„ thickness	12·0	„
Width of the vertical tubes	0·5—1·0	„
„ „ radiating canals	0·5	„
Diameter of the cœnosarcal canals	0·1—0·15	„
„ „ ampulla-like widenings	0·1—0·2	„

Locality and geological position.—The only specimen of this species existing in the Salt-range collection was found by Mr. Wynne, Trans-Indus at Bilot, in the middle Productus-limestone.

Remarks.—Also in this species, as in the preceding one, the preservation causes some difficulty in the attempt to interpret the pictures one sees under the microscope. The specimen, after its deposition in the rock, has evidently been infiltrated with much calcareous matter, which so intimately united with the calcareous trabeculæ that a distinction is no longer possible. We thus find that great parts of the fossil are composed of nothing but a compact mass of limestone, which, in the sections prepared for inspection, become generally traversed by numerous little cracks, which form a fine reticulation that could easily be misleading. In our figures 2 *c*, *d*, of Pl. CXVIII, these fine reticulations can be everywhere observed within the substance of the calcareous parts, and it must be borne in mind that they are nothing but cracks, and not structural features.

There is but little else to be remarked. The species is, in its general structure, not very far distant from *Disjectopora milleporæformis* described above. However, already the outward appearance of the entire hydrophyton suggests the idea that the two are specifically different. The whole shape is reversed, being conical in the one, and more or less lamellar in the other. The surface is rugged in the first, and smooth, only slightly undulating, in the second of the two species, and thus, even if the generic differences were not present, the two had to be considered as different species.

Of other forms none is known to us which could be compared more closely with the present species. As in its general appearance *Irregulatopora undulata* has much similarity to some forms of sponges; something allied to it may have been described under that head, but we are not aware of it, as the intimate structures of such things are only partly known.

Sub-Order: TUBULARIÆ.

Family: *SPHÆRACTINIDÆ*, Waagen & Wentzel.

The forms belonging to this sub-order are chiefly different from those of the preceding sub-order; in that the essential parts of which the hydrophyton is built up are little stolon-like tubes, which form a network, and from which the different sorts of zooids are developed. These tubes are mostly chitinous or of a horny substance, and it is doubtful whether they ever are built up of calcareous matter. The spaces between these tubes are filled with laminar expansions, either of a horny or of calcareous substance, which expands at intervals into little cones or spines, containing in their cavities the so-called skeleton zooids of Grobben.

The stolonal tubes are often of a boring nature, penetrate the calcareous substance of shells, and slowly dissolve the calcareous matter altogether.

The lamellar expansions extend in concentric layers, one supported on the spines of the other, thus forming a concentric laminated mass, which in a vertical section appears to form an irregular network.

In fossil forms, it seems the stolonal tubes are never preserved, and thus it becomes doubtful whether they were ever of a calcareous nature. The impressions of them, however, are visible in fossil species, forming furrows composing hexagonal meshes on the surface of the hydrophyton, which give to the whole a very characteristic appearance. These furrows are, however, characteristic only of certain forms, whilst in others they are apparently absent, and in these we have no signs of the former existence of stolonal tubes, though they may have been present. Nevertheless, as these stolonal tubes are just the most important part of the hydrophyton of the *Tubulariæ*, the zooids always taking their origin from them, the systematic position of the forms in which the former existence of such stolonal tubes cannot be proved, must remain somewhat doubtful; such forms at least cannot be directly united with *Hydractinia* and its allies, which have the stolonal tubes most distinctly developed.

In former days, when all the *Stromatoporidæ* and similar things were considered as more or less nearly related to *Hydractinia*, a more close distinction between the several forms was not necessary; but now, after we have recognised that a great part of these fossils could not be compared to *Hydractinia*, but were rather nearly related to *Millepora*, the remaining forms must also be subjected to a more close scrutiny, in order to learn how far the old opinion as to their affinity to *Hydractinia* can still be sustained.

We regret to say that the materials in the Salt-range collection belonging to this latter group are very limited, and did not admit of any accurate judgment as to the real affinities of these forms. We, therefore, are unable to advance any definite opinion as to the real systematic position of these things, or to add anything really new to our knowledge of them. Only so much we are able to state, that in a certain number of fossil genera every trace of the former existence of stolonal tubes is absolutely wanting, whilst in others at least the impressions of such can be observed. The affinity of the latter to *Hydractinia* is above any doubt, but whether the former are rightly placed in this vicinity must remain doubtful. According to Mr. Steinmann's indications, this possibility is, however, not excluded, and thus we let them remain in this position with all reserve.

The two groups, however, must certainly be made apparent, and thus we distinguish two families, the one of which bearing stolonal tubes will contain *Hydractinia* and its allies, the other without distinct stolonal tubes, we create to receive *Sphæractinia* and similar forms. We thus have—

I. Family: *HYDRACTINIDÆ.*

Hydrophyton, horny or calcareous, consisting of stolonal tubes connected by lamellar expansions in successive layers; between these layers hollow interlaminar spaces; surface with larger and smaller spines, between which furrows extend.

1. Hydractinia, van Beneden.—Always encrusting, only sometimes forming small branches; recent, and fossil in tertiary and cretaceous beds.

2. **Thalamina**, Steinmann, 1878: Palæontographica, vol. XXV, p. 112, pl. XII, figs. 8, 9.—Hydrophyton more or less arborescent or polymorphous, consisting of laminæ which are partly vertical, partly horizontal, thus forming a network of more or less rectangular meshes. Structure otherwise very similar to that of *Hydractinia*. Typical species: *Thalam. cottaldina*, Orb. sp. The genus occurs not rarely in jurassic and cretaceous strata.

II. Family: *SPHÆRACTINIDÆ*, Waagen & Wentzel.

Hydrophyton always calcareous, consisting of concentric lamellæ supported on vertical pillars, which are sometimes also developed in a lamellar shape. Lamellæ and pillars are mostly pierced by more or less frequent openings. Stolonal tubes have not been observed up to the present.

The general outline of the hydrophyton is roundish, spheroidal, elliptic or cylindric.

1. **Sphæractinia**, Steinmann, 1878: Palæontographica, vol. XXV, p. 115, pl. XIII, figs. 3, 7.—Hydrophyton spheroidal. Surface of the lamellæ provided with tubercles on which rather large canals open; smaller pores are disseminated between them, the openings of which are placed on smaller tubercles. Vertical pillars mostly alternating regularly. Typical species: *Sphæract. diceratina*, Steinm. Jurassic of Stramberg.

2. **Ellipsactinia**, Steinmann, 1878: Palæontographica, Vol. XXV, p. 116, Pl. XIV, Figs. 1—7.—Hydrophyton ellipsoidal sometimes branching. Concentric lamellæ of somewhat variable thickness, pierced by numerous pores on their surfaces sometimes with a network of grooves. Pillars very few, always oblique. Typical species: *Ellipsactinia ellipsoidea*, Steinm. From the jurassic deposits of Stramberg.

3. **Parkeria**, Carpenter, 1870: Philos. Transact., Vol. 159, pt. 2, p. 721, Pls. 72-76.—Hydrophyton more or less spheroidal, on the whole somewhat similar to *Sphæractinia*, but the pillars are described as being hollow: cretaceous.

4. **Loftusia**, Brady, 1870: Philos. Transact., Vol. 159, pt. 2, p. 743, Pls. 77-80.—Hydrophyton ovoid. Lamellæ not quite concentric, but more or less spirally arranged, on the outer side compact, on their inner surface traversed by labyrinthine canals, which are also present in the pillars: eocene of Persia.

5. **Stylodictyon**, Nicholson and Murie, 1879: Journ. Linn. Soc., Zoology, Vol. XIV, p. 221, Pl. 3 figs. 1—3, non figs. 4—8.—Hydrophyton massive, having mastoid processes, in which the lamellæ are concentrically arranged, the centre of the processes occupied by reticulated tissue. Lamellæ and pillars traversed by numerous openings. Typical species: *Stylodict. retiforme*, Nich. and Murie. Devonian (Hamilton group) of North-America.

We have shown already that the two species subsumed by Nicholson and Murie in the genus represent two very far deviating types, of which the first, *Stylod. columnare*, Nich., according to the figures, appears to be something like *Labechia*, whilst the second, represented by *Stylod. retiforme*, Nich. and Murie, belongs to the *Sphæractinidæ*. We have ignored here in a provisional manner the first type, as really intelligible figures of it do not exist, and have restricted the name to the second type, as the figures of this are well intelligible, pending better information.

6. CIRCOPORA, Waagen, and Wentzel, n. gen.—Hydrophyton cylindrical with rare lateral protuberances. Single lamellæ of a hemispherical shape supported on radial pillars of about the same thickness as the lamellæ. Both elements frequently but irregularly perforated. Typical species: *Circop. faveolata*, Waagen and Wentzel, n. gen. et sp. Middle Productus-limestone of the Salt-range.

These are the forms belonging to the sub-order *Tubulariæ* which have been found up to the present in a fossil state. We see that the family *Hydractinidæ* commences in upper-mesozoic times and extends from there up into the actual seas, where it has its greatest development. The family *Sphæractinidæ* commences already in the devonian epoch, has a single representative in permian times, and finds its chief development in mesozoic strata, where not less than three genera exist, to be at last extinguished in the lower tertiary beds.

In the Salt-range only the family *Sphæractinidæ* is represented by a single genus.

Genus: CIRCOPORA, Waagen & Wentzel, n. gen.

The general shape of the hydrophyton is elongated, more or less irregularly cylindrical, provided at intervals with large rounded blunt tubercles which apparently sometimes develope into short lateral branches. The upper termination was probably hemispherical, whilst the lower end was apparently more or less pointed, whereby the general shape in smaller specimens becomes also very elongately reversedly conical.

The skeleton consists of a series of numerous hemispherical lamellæ, all arranged concentrically in the direction of the longer axis of the hydrophyton. The convex side of the lamellæ is directed upwards, the concave side downwards. These lamellæ are connected together by numerous straight pillars or partitions, which are all vertical to the surface of the lamellæ. They are either narrow, and of equal thickness throughout, or they are somewhat broader and thickened at both ends, where they unite with the lamellæ, also somewhat of a laminar nature.

The lamellæ as well as the pillars are traversed by numerous pores, which are, however, very irregularly distributed. They are somewhat more numerous in the lamellæ than in the partitions, and are in the former position often united in groups.

The interlaminar spaces are very considerably broader than the laminæ and are subdivided in more or less rectangular or roundish chambers by the partitions or pillars. These chambers communicate with those above and below through the pores by which the lamellæ are traversed, but also laterally they are mostly in communication by the pores which traverse the partitions.

The skeleton is not always so regular as has been here described. Chiefly when one of the tubercles mentioned above is being formed, the concentric lamellæ begin to become irregular and suddenly bend out strongly, so that two systems of concentric lamellæ are slowly formed, bending round two different centres. Often also the partitions of several successive layers are placed approximately in the same position and direction, and then form long, more or less straight, continuous calcareous walls, which often traverse the skeleton for rather long distances. Other irregularities, which are also visible in our figures, cannot be satisfactorily explained. They are probably also due partly to preservation.

In our figures (Pl. CXIX, fig. 2 *a*, *b*. and Pl. CXX, fig. 2 *a*, *b*.) we see also that the cut edges of the lamellæ as well as of the pillars often show a dark line in the middle. This dark line corresponds to a structure which very generally occurs in the corals proper, and which has been termed there the primordial wall.

The genus is rather nearly related to several of those genera which are enumerated above as belonging to the family *Sphæractinidæ*. There is *Sphæractinia* itself which must be compared. First, the general shape of the hydrophyton in both genera is different. Then, the structure is, on the whole, much more regular in Steinmann's genus that it is in the Salt-range form. The pores on the lamellæ are much more numerous in our *Circopora*, and are not placed on warts, as is the case in the jurassic fossil. Thus, the difference between the two genera is rather obvious.

Yet more nearly related than *Sphæractinia* is *Ellipsactinia*. In this genus also cylindrical forms of the whole hydrophyton appear, and sometimes an attempt is made towards the development of branches as in our fossil, but the internal structure is considerably different. The concentric lamellæ are much thicker, the partition walls or pillars much more scarce and always oblique, and the canals traversing the laminæ much scarcer and larger, so that also in this case the distinction is not difficult.

The genus is represented in the Salt-range by two species, which will receive the names of *Circop. faveolata* and *Circop. tubulosa*. In other parts of the world the genus has not yet been detected.

1. CIRCOPORA FAVEOLATA, Waagen & Wentzel, n. gen. et sp., Pl. CXIX, figs. 1, 2; Pl. CXX, fig. 1.

Hydrophyton irregularly cylindrical or very elongately reversedly conical, terminated at the upper extremity by a hemispherical outline, with the other end probably attached to foreign bodies.

Lateral surface of the hydrophyton rather rugged, apparently covered with a kind of epitheca, which has transverse irregular, but more or less parallel wrinkles, but on the whole very badly preserved. There are at intervals large blunt tubercles, the beginning of ramifications, which are, however, apparently never developed into real branches.

If the epitheca is worn off by weathering, as generally happens, the whole surface is covered with more or less parallel lines, all somewhat vaulted towards the upper end of the hydrophyton, and separated from each other by narrow furrows. These lines are the edges of the lamellæ of which the skeleton is composed, and which are on the whole of a hemispherical shape. They are connected together by vertical walls, which traverse the furrows, and thus form parallel series of little cells, to which the name ought to allude. This structure is, however, well visible only for short distances on the specimens that serve for description. Generally the action of weathering has worn away a more or less considerable part of the skeleton, and then this natural section is all covered with highly arched concentric lines, between which off and on the little cells can be distinguished.

At the upper extremity of one of the specimens the last terminal lamella is partly preserved, and one sees that the surface is rather smooth, without tubercles and provided with numerous fine pores, which are rather irregularly distributed and gathered here and there in irregular groups.

Otherwise there is but little to be said of the outward appearance of these things. They are mostly rather badly preserved, and their real structure can generally only be made out by microscopical sections.

In such sections one sees that the substance of the lamellæ is very thin and compact, often showing in the middle a dark line, a structural peculiarity which can often be observed in the different parts of the skeleton of the *Cœlenterata*. Horizontal and vertical sections do not look markedly different with regard to these lamellæ. They always form more or less concentrically arranged lines, according to their approximately hemispherical shape. In both cases we see that they are frequently perforated by small pores, in which case the cut edges of these lamellæ are resolved into dotted lines.

The partition walls, vertical lamellæ or pillars, as one also may call them, look on the contrary rather different in vertical and in horizontal sections. Chiefly they are not contiguous as are the concentric lamellæ; and though of a lamellar nature, they are mostly of very moderate extent. They are arranged more or less radially in a horizontal as well as in a vertical direction, and are generally vertical to the surface of the concentric lamellæ. In horizontal sections (Pl. CXIX, fig. 2 *a*) they generally do not traverse more than one interlaminar space, are very thin and of equal thickness for their whole extent and are joined at sharp right-angles to the substance of the lamellæ. Sometimes, but not always, they show perforations. In vertical sections (Pl. CXIX, fig. 2 *b*) they are, if possible, even still more irregular than in horizontal ones. For comparatively large distances they appear to be almost entirely absent, whilst at other places they are rather thick and traverse obviously four and five interlaminar spaces in succession. In other places again, these partition walls are restricted to a single interlaminar space. This irregularity is further augmented by the mode of perforation that prevails. There are often for long distances no pores at all, whilst in other cases, chiefly when the partition walls are restricted to a single interlaminar space, pores are of regular occurrence, and there are even cases, where such walls are resolved into a series of dots.

Though this great irregularity prevails, yet the general arrangement of the different parts of the skeleton can be deduced with sufficient certainty from the facts ascertained from the microscopical sections.

The measurements of the specimens at our disposal are as follow:—

Entire length of the hydrophyton unknown.	
Greatest thickness	15 to 18 mm.
Width of the interlaminar spaces	0·21 „ 0·28 „
Thickness of the lamellæ	about 0·07 „

Locality and geological position.—There are altogether two specimens of this species preserved in the Salt-range collection, which were both found by Mr. Wynne in the middle Productus-limestone of Morah.

Remarks.—As regards the preservation of these fossils, it must be remarked that, as in *Ellipsactinia*, so in the present species foreign bodies are very often enclosed in the substance of the hydrophyton and a part of the irregularities of growth are certainly caused by these.

It has already been stated above that the forms belonging to the genus *Circopora* bear a more or less close resemblance to *Sphæractinia* and *Ellipsactinia*, and this is chiefly in a high degree the case with the present species. *Sphæractinia* has similarly thin lamellæ, which on the whole are also rather similarly arranged. But whilst these lamellæ are pierced by numerous holes in our *Circopora faveolata*, they are nearly compact in Steinmann's genus, and canals or holes piercing the lamellæ are only rarely to be observed, and thus the similarity is only an apparent one. Quite the same is the case with *Ellipsactinia*. Here the similarity is yet a more distant one. The lamellæ are much thicker, of an entirely different structure, and the partition walls are very rare and always strongly oblique. The perforations of the lamellæ, on the contrary, are similar in both fossils.

With regard to other forms, as *Parkeria* or *Loftusia*, there also exists a certain similarity, which is however only quite surperficial.

2. CIRCOPORA TUBULOSA, Waagen & Wentzel, n. gen. et sp., Pl. CXX, fig. 2.

Hydrophyton irregularly, elongately, cylindrical; not quite straight but variously bending; provided at intervals with blunt tubercular processes, giving the impression of a commencing ramification. Upper end hemispherically rounded; the lower extremity is not preserved.

Lateral surface of the hydrophyton very rugged, bending out and in the most irregular manner, but not sufficiently well preserved to observe whether an epitheca was present or not.

If the surface is somewhat worn, the same lines appear as have been described in the preceding species, but everything is of a coarser nature. The substance of the lamellæ is much thicker, and their distances much larger. Otherwise they are similarly arranged. If the weathering only just touches the surface, the lines appear more or less straight, though rather irregular. If the weathering proceeds deeper, the lines become more and more vaulted, until towards the centre they are semi-circularly arched. The lamellæ are connected together by partition-walls or pillars, which cause a reticulated appearance of the weathered surfaces.

The surface of the uppermost terminal lamina cannot be observed, as it is covered up by rock matter.

The true characters of the species can only be recognised in microscopical sections. We have figured such sections on Pl. CXX, fig. 2 *a*, *b*, of which fig. 2 *b* is a horizontal and fig. 2 *a* a vertical section. We see at once in these sections that the solid parts, forming the skeleton, are rather robust, and exhibit generally not straight, but to a certain extent rounded outlines; this is caused by the circumstance that the median portion of each single part of the skeleton is attenuated, whilst both ends are more or less swollen, whereby rounded pores and canals are circumscribed, quite different from those described in the preceding species. The lamellæ forming the concentric layers, of which the whole skeleton is composed, are well distinguishable in both sections. They are of tolerably equal thickness for longer distances, often traversed by pores and frequently joined by partition-walls, which are strongly broadened at the points of junction and considerably attenuated in the middle. Also there appears often in the middle of these hard parts a dark line or else a dark mark, which is caused either by structural peculiarities or by a singular mode of preservation, but never indicates the existence of fine canals in the centre of these parts.

The interlaminar spaces are of considerable width, but rather irregular in their extent, often interrupted or displaced, but on the whole following a concentric arrangement. The partition-walls or pillars are still far more irregular, and often absent for longer distances. At other places they are again more numerous, and then often continued through a series of successive interlaminar spaces. They are not perforated by pores so frequently as the lamellæ. Where their distribution is somewhat more regular, rounded canals or chambers are partitioned off by them, which acquire a nearly circular outline by the singular development these partition-walls have attained.

In the horizontal section (Pl. CXX, fig. 2 *b*) one sees a number of successive concentric lamellæ which show there a singular diverging arrangement, which is caused by the circumstance that the figure represents that part of a section where one of the external tubercles is just on the point of developing. Between these concentric lamellæ the partition-walls or pillars extend here in a tolerably regular manner and circumscribe nearly circular canals or chambers.

In the vertical section (Pl. CXX, fig. 2 *a*) which is taken not far from the centre of the hydrophyton, the interlaminar spaces appear much wider, and interrupted by but few partition-walls, which are partly incomplete. Towards the right of the figure the skeleton becomes irregular on account of the intrusion of a foreign body (Dybowskiella).

The measurements are as follow :—

Entire length of the hydrophyton unknown.	
Greatest thickness	21·0 mm.
Thickness of the concentric lamellæ	0·1—0·12 „
Width of the interlaminar spaces	0·4—0·5 „

Locality and geological position.—The only specimen of this species, preserved in the Salt-range Collection, was found by Mr. Wynne in the middle Productus-limestone of Morah.

Remarks.—As in the preceding species so also in this one, the regular growth of the hydrophyton is often interrupted by foreign bodies that are included in the substance and have been overgrown by the colony. In this respect a certain similarity to *Ellipsactinia* cannot be denied, but whilst in Steinmann's genus these foreign bodies do not influence the growth of the whole hydrophyton, in the present form this influence is rather considerable, as appears from our figures.

The nearest relation of the present species is beyond doubt the species previously described under the name of *Circop. faveolata*, W. and W. The external shape of the two species is nearly identical, and it would be impossible to distinguish between the two; but in microscopical sections a difference would soon become apparent. In fact, in the intimate structure the two forms are as different as they are similar in external appearance. If we compare the microscopical sections of the two species, drawn on Pl. CXIX, and Pl. CXX, we see immediately that this difference chiefly lies in the different structure of the skeleton. Every part of this species is more robust than in the preceding one : the thickness of the concentric lamellæ is 0·1 to 0·12mm. in *Circopora faveolata*, the same is 0·6 to 0·8mm. in the present species. The interlaminar spaces, which are 0·21 to 0·28mm. in the first species, are 0·4 to 0·5mm. in the present one ; this difference is so considerable that on weathered surfaces it can be observed even with the naked eye or with a common pocket-lens. But also the shape of the different parts of the skeleton shows considerable differences. The partition-walls, or pillars, are considerably broadened at the points of junction with the concentric lamellæ, and thus circumscribe round holes or tubes, to which circumstance the name *Circopora tubulosa* is meant to allude. Thus, we see that the two certainly represent different species, but on the other hand they are also again so much in accordance with each other, that they certainly belong to one and the same genus.

There is, however, yet another fossil with which the present species must be compared; this is *Stylodictyon retiforme*, Nichols. and Murie. The transverse or horizontal section represented on Pl. III, fig. 3 of Nicholson and Murie's paper shows towards the centre similar rounded cells, but more towards the periphery this character soon disappears, and the whole becomes more similar to *Circop. faveolata*, though somewhat more irregular. On the whole there is no doubt a certain similarity of type between *Stylodictyon* and *Circopora*, but the reticulated tissue in the centre of the columns and the massive form of the hydrophyton in *Stylodictyon* make a generic distinction between the two absolutely necessary, and thus also the specific similarity between *Styl. retiforme* and *Circop. tubulosa* is only an apparent one.

SUPPLEMENT TO THE BRYOZOA.

Family: *PETALOPORIDÆ*, Waagen.

In the course of investigations regarding the corals of the Salt-range, we had occasion to study in detail two small fossils, which to all appearance belonged to the genus *Rhombopora* of Meek, and at first we took them to be corals. But after we had made several sections, as many as the very scanty material would allow, we soon found, that the mode of gemmation prevailing in these *Rhomboporæ* was not in any way similar to that occurring in the corals, but was absolutely identical with what we generally found to be the case in the *Bryozoa*; thus, we could not describe these two fossils among the corals, and having recognised them to be *Bryozoa* we are obliged now to give a supplement to this class for the description of these two little species.

After having shown the probability that a great many of the fossils formerly described under the names of *Ceriopora* or *Heteropora* are in reality corals and not *Bryozoa*, it is impossible to employ either of these names any longer for the designation of a family composed of organisms belonging to the *Bryozoa*, so we are obliged to look out for another name.

There exists beyond doubt a group of forms among the *Bryozoans*, in which all the cells are not of the same size, but in which there occur so-called interstitial tubes between the larger cells. Among these forms the genus *Petalopora*, Lonsd., has been studied most in detail as to its mode of gemmation, and is shown beyond any doubt to belong to the *Bryozoans*. Thus, we have chosen this genus for the formation of a family name.

We comprise in this family arborescent colonies of *Bryozoans* in which small interstitial tubes are intercalated more or less frequently between the proper cells. All the cells take their origin in the centre of the branches and are there produced by gemmation, in the mode characteristic of *Bryozoans*. According to this definition the genus *Rhombopora* falls also within the scope of the family. It is represented in the Salt-range by two species.

Genus: RHOMBOPORA, Meek.

Meek characterises the genus in the following manner:—

"Small ramose corals, with non-septate short tubular cells, radiating obliquely outward and upward on all sides from an imaginary axis; cell-mouths rhombic or rhombic-oval, and very regularly arranged in longitudinal and oblique spiral rows, the former of which are sometimes separated by more or less flexuous longitudinal ridges; interspaces usually rather thick, and not pierced by transverse pores, but occupied by very minute non-septate longitudinal cells that are closed and represented at the surface by minute granules or spinules."

To this definition but very little need be added. It should be at once remarked that the present genus does not belong to the corals but to the *Bryozoa*, as is shown most clearly by Mr. Meek's own figure, where the longitudinal section most clearly exhibits the mode of gemmation prevailing in the latter.

As regards the little granules mentioned in Meek's diagnosis, it is worthy of notice that this is only a secondary character, caused by preservation, though it may be present in most species. The cause of this character is the accumulation of sparry matrix at the mouths of such very narrow canals, which often protrudes in hemispherical masses and is of very general occurrence in widely different fossils.

The genus *Rhombopora* is most nearly related to *Petalopora*, Lonsdale, but is distinct from it by the more or less regular arrangement of the cells in oblique rows, and by the absence of those longitudinal ridges which subdivide the surface of most species of *Petalopora*, causing an arrangement of the cells in more or less regular vertical rows.

The genus is represented in the Salt-range by two species, which are both new.

1. Rhombopora obliqua, Waagen, n. sp.

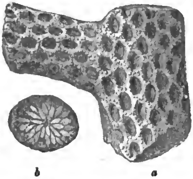

Fig. 31, Rhombopora obliqua, Waagen, n. sp. Specimen from the middle Productus-limestone of Kafirkot: (*a*) lateral view of the fragment; (*b*) transverse section of the lateral branch, badly preserved, both enlarged ten times.

The entire colony is arborescent, composed of small straight stems which bifurcate at intervals, and which have an approximately circular, or only very slightly compressed, transverse section. The thickness of the branches is 2 to 3 mm.

They are composed of short tubes, which originate in a single line in the centre and extend thence upward and outward. They are separated from each other by rather thick walls in which the interstitial tubes are imbedded. The latter are about ten times thinner than the other tubes.

The openings of the tubes on the surface are generally oval and arranged regularly in quincunx, so as to form very steeply ascending oblique rows. They are comparatively rather large, each of them about 0·25 mm. in the transverse, and 0·5 mm. in the longitudinal direction. There are five to seven cells within one oblique row.

The spaces between the cells are occupied by little granules, which surround the cells on all sides, and do not mark off very distinctly rhombic spaces; on the whole they are, however, arranged in single rows. The granules are made up of spary matter and indicate the position of the interstitial tubes. There are none more conspicuous than the rest by greater size or in any other way.

Locality and geological position.—The only fragment of this species in the Salt-range collection was found by myself in the middle Productus-limestone at Kafirkot (Trans-Indus).

Remarks.—The present species belongs to that group of forms which bear a rich ornamentation, and to which belong, of other species, *Rhomb. lepidendroides*, Meek, *Rhomb. interporosa*, Phill., and *Trematop. granulifera*, Hall, which is probably also a *Rhombopora*. The form which is most similar to the Indian fossil is the last of the three mentioned. It comes from the Niagara group of Indiana and has been described by Hall in the twenty-eighth Annual Report of the New York State Museum. It is distinct from the species here under description solely by the more sparingly distributed granules between the cells and by the more slender branches. This all, however, applies only to the outward appearance. The internal structure of the American species is not known, and it may well be that it is not a *Rhombopora* at all, but some form belonging to the *Monticuliporidæ*.

. Next in similarity comes *Rhombop. interporosa*, Phill., from the mountain-limestone of Yorkshire. This species has much more slender branches, and the cells are much smaller, and comparatively further distant from each other.

Rhomb. lepidendroides, Meek, is much more regular in its sculpture, and the oblique rows of cells are much less steep.

2. Rhombopora polyporata, Waagen, n. sp.

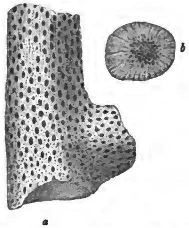

Fig. 32, Rhombopora polyporata, Waagen, n. sp. Fragmentary specimen from the topmost beds of the upper Productus-limestone of Virgal: (*a*), lateral view; (*b*), transverse section of another specimen, both enlarged ten times.

The shape of the entire colony is apparently arborescent, but only fragments are known to me. They represent small straight branches, which sometimes bifurcate. The transverse section is mostly not circular, but more or less oval or compressed, chiefly at the spots where a bifurcation takes place. The diameter of the branches is on an average 2mm.

The branches are composed of little tubes which originate at an imaginary axis, and diverge thence upward and outward. They are present in great numbers, and give to the branches somewhat the appearance as if belonging to *Geinitzella* or the like. But on a closer examination one soon finds, that the mode of gemmation is that characteristic of *Broyozoa*. The walls between the tubes are rather thick, and pierced by numerous very thin interstitial tubes.

The surface of the branches is remarkably smooth, without distinct subdivision into rhombic spaces, nor are there any granules surrounding the cell-openings.

The cell-openings are very small and of an oval shape. Their longer diameter is about 0·2mm., the shorter one 0·1mm. They are about their own diameter distant from each other. These distances are occupied by numerous interstitial pores, which are very fine, all of about equal size and generally arranged in single rows. The cell-openings are distributed rather indistinctly in quincuncx, so that more or less regular vertical and oblique rows can be distinguished. There are thirteen to fourteen such openings within one of the oblique rows.

Very rarely there occur a kind of maculæ, where no large openings are present, but the whole is occupied solely by interstitial tubes.

Locality and geological position.—There are two fragments of this species preserved in the Salt-range collection, which were both found by myself in the topmost beds of the upper Productus-limestone of Virgal.

Remarks.—This species also is again more or less nearly related to *Rhombop. interporosa*, Phill., as the entire arrangement of the cells and distribution of the pores between them is very similar in both species. On a closer comparison, however, one finds again that the branches are much more robust and the cells more numerous, as there are up to 14 cells contained in one oblique row. Another peculiarity consists in the circumstance, that the pores between the cells are in the present species often arranged in vertical rows, as in *Petalopora*.

From the species described above, the present one is distinct by the much smaller cells.

On the whole, it is remarkable how much the present species resembles a true *Petalopora*, and one might even be doubtful whether it should not be rather described in that genus. I have left it in the genus *Rhombopora* on account of the, on the whole, quincuncial arrangement of the cells and of the absence of vertical prominent ridges on the surface. It cannot, however, be denied, that this species forms to a certain extent a transitional link between the geologically older *Rhomboporæ* and the more recent *Petaloporæ*.

Class: AMORPHOZOA.

Order: PHARETRONES.

Sub-Order: SPHINCTOZOA.

Family: *SPHÆROSIPHONIDÆ.*

In treating of the present class of animals, we rather prefer to use the name of ***Amorphozoa***, introduced by Blainville, than that of *Spongitæ* or *Spongiaria* applied by Grey, Fleming, or Milne-Edwards. The latter name seems to us too concrete, applying chiefly to the bath-sponges, whilst very many other and widely different things must also be included in the class. Then the name ***Amorphozoa*** is so very appropriate to the organisms here under consideration that it would be a pity that such an excellent name should not be made use of. Moreover, the name ***Amorphozoa*** is more in accordance with the names applied to the other classes of *Cœlenterata*, and ***Amorphozoa, Hydrozoa, Anthozoa*** sound very well together.

This, however, implies that we consider the ***Amorphozoa*** as belonging to the ***Cœlenterata.*** There are many reasons for doing so, as will be explained later on, but all, or most, of these are not so much founded on their general organization as on their minute structure; and it is well known, and has been adduced already by Steinmann, that the skeleton elements of certain ***Amorphozoa*** are astonishingly similar to those of the ***Alcyonaria.***

If, however, they are *Cœlenterata* they are a very degenerate set, which have even altogether lost their stomach, the chief criterion of the ***Cœlenterata.*** The chimney-like cavity which is present in the centre of many forms can certainly not be considered as such, as it is only of accidental occurrence. This degeneration has been brought about by the fundamental mistake committed by these animals, that they attach themselves as *Gastrulæ* by the oval end of their body to foreign bodies, whereby the mouth and stomach could be of no further use to them and so became entirely obliterated. Naturally the animals must make up as best they can for this deficiency, but a real stomach they never attain. There is a cavity often developed on that end of the body opposite the mouth, and this cavity corresponds probably to the chimney-like cavity of certain forms; but as there is no real mouth there is no real stomach, the cavity serves only for the ejection of water, and the so-called osculum at the end of it must rather be considered as anus than as mouth.

The means of nutrition are probably chiefly effected by the numerous canals that traverse the body of these animals.

That in their essence these organisms are related to the *Cœlenterata* and only degenerate by quite abnormal circumstances, is shown partly by the mostly radial arrangement of these canals, by the similarity of the elements of their skeleton to those of the *Alcyonaria*, and by the close approximation of certain forms to the Corals, as will be demonstrated later on.

It is impossible to begin the description of any form belonging to the sponges, without recurring to Zittel's most important papers on the structure of the animals belonging to this class.

Zittel in his Handbook distinguishes seven orders within the class; of which, however, only five have been found up to the present with certainty in a fossil state. The last of these is made up of the *Calcispongiæ*, of which the *Pharetrones* form only a family.

The living forms of the *Calcispongiæ*, which are found in rather great numbers in our present seas, are all characterised by a skeleton, which is made up numerous simple or three-radiate or four-radiate calcareous spicules, which are often packed together in great numbers, forming thick walls, which, however, always remain free and are never blended together, nor forming a meshwork, as in the *Hexactinellidæ*, nor in any other way.

The *Pharetrones* are a group of forms that occur in a fossil state only, and which possessed a calcareous skeleton, as is amply proved by Zittel's investigations; and by the more recent studies of Dr. Steinmann, who re-affirms Mr. Zittel's results in this respect in all details. Nevertheless, the structure of the *Pharetrones* deviates rather widely from that generally occurring in living *Calcispongiæ*, so much so that the opinion has been expressed, that they should not be considered as belonging to the *Amorphozoa*, but rather as some other form of the *Cœlenterata*, perhaps *Alcyonaria*.

The difference of all the *Pharetrones* from the *Calcispongiæ* consists chiefly in the circumstance that either spicules are of rare occurrence, or can at least not be distinguished, the entire walls consisting of a rather compact, perforated, calcareous mass; or if spicules can be distinguished in greater numbers, then they are blended together in different ways, but always forming a kind of fibres, in which they are either entirely or only partly imbedded.

Nevertheless, we are far from asserting that there existed no connection whatever between the *Pharetrones* and the recent *Calcispongiæ*. On the contrary, we believe that a line of continuous development can be established from the *Pharetrones* to the *Calcispongiæ*. This development manifests itself in several ways. First in the development of the spiculæ. In the palæozoic genera and species of *Pharetrones* only simple fusiform spicules occur; in the cretaceous species tri-radiate spicules are of frequent occurrence; and in the recent *Leucones* tri-radiate and four-radiate forms by far predominate. As the last remnant of the fibres of the *Pharetrones* is to be considered probably the plaster-like substance called "*Stäbchen-Mörtel*" by Häckel, occurring in the *Leucones*. Second, in the development of the canal-system. This is very simple in the palæozoic *Pharetrones*, more developed in the cretaceous ones, and of an extreme degree of development in the recent *Leucones*. Now we think it not quite impossible that the hard parts may have degenerated, the compact shelly parts and fibres being dissolved into spicules, in favour of the development of the canal-system. Though all this may have been the case, the *Pharetrones* must yet have been in their general structure very far deviating from the recent *Calcispongiæ;* and the tissues that secreted the compact shelly layers and fibres in the *Pharetrones* must have been more similar to those of the corals than the tissues of the recent *Calcispongiæ.* It appears thus more or less doubtful if such a development could be termed a progressive one. It is only so in a certain sense.

The materials contained in the Salt-range collection (all *Sphinctozoa*) are tolerably extensive, though not representing a great number of genera and species, but, we regret to say, these materials are rather indifferently preserved, and the substance of the walls is always transformed into a sparry mass, in which it is impossible to distinguish any structure. Thus, we are not in a position to add many new facts to those already made known with regard to these organisms by Zittel, Steinmann, and Dunikowsky.

The latter has more recently treated in detail some of the *Pharetrones;* but, though his work is otherwise so excellent, it seems to us that with regard to the fibres he has caused the questions here at stake rather to be obscured than cleared up, as he considers the fibres of which the skeleton of the *Pharetrones* is generally made up to be secondary elements, produced only by the process of fossilisation.

Dunikowsky must admit that these fibres are of very general occurrence in the *Pharetrones,* and that there are no forms among the whole order in which they would be absent, and which would be composed of more or less free spicules. If the fibres were of secondary origin and produced only by the influence of the decomposing organic matter upon the calcareous spicules and the fossilising substances, it would be difficult to understand how in all cases the same effect was attained, resulting in the formation of compact fibres. According to Dunikowsky's views the fibres are really of inorganic nature and include only fragments of organic substance, *i.e.,* those parts of the spicules which have not entirely been dissolved. If this is the case, then it is very strange how the whole fibres have been replaced by silica in silicified specimens, as it is the rule in the process of silicification that only the organic tissues are replaced by silica, whilst all that is not organic remains of a calcareous nature. That the entire fibres are transformed into silica is amply proved by Zittel's own observations, and thus it becomes highly probable that they are of organic nature, and not of secondary origin. Besides this, there is sometimes a distinct structure distinguishable within the fibres, and sometimes even something like a primordial fibre can be observed comparable to the primordial walls in corals, and followed on both sides by secondary thickenings. From all this it becomes highly probable that the fibres are an original feature of the *Pharetrones,* restricted to the order and distinguishing it from all the rest of the *Amorphozoa.* Thus, though the skeleton elements of the *Pharetrones* are of a calcareous nature, yet these organisms cannot be placed together with the *Calcispongiæ* of our present seas.

The fibres of the *Pharetrones* are of very different development in the different forms: in some their original composition of spicules, melted together by organic calcareous substance, is very conspicuous; whilst in others this composition almost entirely disappears, the fibres being transformed into porous calcareous walls or even into compact lamellæ, which in every respect can be compared to the lamellæ forming the vesicular tissue in corals.

The most remarkable forms in this latter respect have been described by Steinmann under the names of *Amblysiphonella*, *Sebargasia*, *Cryptococlia*, *Sollasia*, &c. This group is largely represented in the Salt-range, and we had good means for studying the structure of the skeleton. As in all the *Sphinctozoa*, it is composed of a series of hemispherical or shortly cylindrical pieces. Sometimes there is a central tube, sometimes not. Each piece has a thick strongly porous wall covering the peripheral and upper parts, and lining the central tube, if there is one. The lower surface remains free, and is occupied by the upper part of the wall of the preceding piece. In this manner a series of chambers is formed, and specimens in which a central tube is present are not unlike the shell of an *Orthoceras* with a wide central siphon. The chambers thus formed are filled with a very irregular vesicular tissue, not dissimilar to the vesicular tissue of some *Tetracoralla*, such as *Cystiphyllum*, *Strephodes*, &c., the single vesicles being chambered off by irregularly curving shelly lamellæ.

Regarding the finer structure of the elements of the skeleton, the outer wall is pierced by two sets of very numerous pores, larger and smaller, as in a sieve. The larger ones are easily perceptible with the naked eye, arranged more or less in quincunx; the smaller ones are extremely numerous, and well distinguishable with a common pocket-lens. The walls of the vesicles on the contrary appear, even if strongly magnified, as thin compact shelly lamellæ. So far no spicules have been detected by us within these parts of the skeleton. The rock, however, that surrounds these parts, often swarms with small, single, fusiform spicules, which have often a thorny surface, and sometimes have the central canal preserved. As spicules are not of very general occurrence in the calcareous rocks of the Salt-range, it is somewhat surprising to meet them here so frequently, and the supposition appears not very hazardous that these spicules were originally imbedded in the soft parts of the animals that also produced the other hard parts of these bodies.

The evidence of the features we have exposed up to the present is of a somewhat conflicting nature. The greater part, it must be confessed, is not entirely in favour of the opinion that these fossils should be considered as *Amorphozoa*, but the compactness of the hard parts and the existence of a vesicular tissue rather points to the conclusion of these organisms being real corals, perhaps *Alcyonaria*, as advocated by Steinmann, rather than *Amorphozoa*. On the other hand, there are some features which forbid their being placed with the true corals. This is chiefly the great porosity of the walls, which are like a sieve, and must have allowed a free percolation of the sea-water. We must admit such a supposition, as in forms with hemispherical pieces or segments the water would have had no access to the interior of the animals, the chambers being closed all round, except by these pores, and thus these cannot have been closed by organic matter. But then the body of these

Sphinctozoa must have been very differently constructed from that of real corals and must have been much more similar to that of the *Amorphozoa*.

Another feature that is not developed in the Indian materials, but which is otherwise of frequent occurrence, is the existence of numerous ostia on the surface of many forms, such as *Enoplocœlia*, Steinm., *Sollasia*, Steinm., *Celyphia*, Pomel, &c. These in connection with the central tube with its osculum, as in *Enoplocœlia*, give an appearance to these things so entirely amorphozoic that their real nature can barely be doubted.

To these features must be added the occurrence of spicules, either imbedded in the soft parts or forming part of the fibres.

All this taken together, the greatest probability seems to be that the *Pharetrones* are in reality sponges, though they cannot be united with the *Calcispongia* of our present seas, but deviate rather far from them.

On the other hand, it cannot be denied that they are rather nearly related also to the real corals, chiefly the *Alcyonaria*. This proves two things: *first*, that the *Amorphozoa* form most probably part of the *Cœlenterata*, and not of the *Protozoa*; and *second*, that the *Pharetrones* are the most highly organized of all the *Amorphozoa*, approaching in their structure very near the true corals, thus obliterating more or less the fundamental difference that exists in the development of corals and sponges, the former fixing themselves in the *gastrula* state by the closed ab-oral end of their body to foreign bodies, the latter doing the same by the mouthed end. Only later on, the latter develop at the opposite end a central cavity which is probably to be considered as morphologically different from the gasteral cavity of the corals. Nevertheless, it seems that both can develop into forms which approach each other very closely.

We thus may be justified in considering the *Pharetrones* as an order of sponges by themselves; forming to a certain extent a transitional link between sponges and corals, distinct from the first by a more solid skeleton and from the latter by perforated walls of the body allowing the sea-water to enter laterally.

Steinmann distinguishes among the *Sphinctozoa* four families, of which two, the *Sphærosiphonidæ* and the *Sphærocœlidæ*, are represented in the Salt-range.

Steinmann (Neu. Jahrb. f. Min. 1882, II. p. 163) characterises the family *Sphærosiphonidæ* in the following manner. The family is distinct from the "*Sphærocœlidæ* by the presence of a more or less perfect central tube, from the *Verticillitidæ* by the absence of a fibrous tissue filling the interior of the segments. Walls pierced by straight or but little curved canals; a central osculum present. Only *Enoplocœlia* is covered with a thick epitheca, which is perforated by a greater number of small ostia. Fibres of the skeleton, as far as their structure can be made out, consisting of long, slender spicules, without an axial canal."

To this definition we may perhaps add that in the forms of the Salt-range a vesicular tissue is present, occupying the interior space of the segments.

In the Salt-range only a single genus, belonging to the family, has been found up to the present.

Genus: AMBLYSIPHONELLA, Steinmann.

As Mr. Steinmann has not formulated a real diagnosis of the genus, but described only the single species at his disposal, we must try to find out such characters as appear of importance for the characteristic of the genus.

It may, we think, best be characterised in the following manner :—

Body elongated, more or less cylindrical, with many transverse successive furrows, by which the entire body is divided into single segments. Each segment shows a rather thick solid outer wall, which is slightly convex on the outer side, then bends inwards, becoming approximately horizontal, and then again bending down, forming thus an inner wall, and giving a ring-shaped appearance to all these segments. In such a manner a wide central tube is formed, which traverses the body for nearly its entire length and terminates at the upper extremity in a comparatively large osculum. At the base of the body of the sponge it terminates on a shelly vesicular tissue, the same tissue with which also the hollow space of each segment is either partly or entirely filled up.

The wall which thus covers the outer upper and inner side of each segment shows everywhere on its surface pores of two kinds; smaller ones which are present in very great numbers, and larger ones which are less numerous, arranged somewhat in quincunx and easily visible to the naked eye. These pores form the entrances to little canals, which pierce the substance of the wall, are mostly straight, and generally simple, only rarely bifurcating. The smaller pores also are in connection with canals, but these are mostly obliterated by the process of fossilisation. The substance of the wall is finely granular, but we were not able to distinguish any spicules. Besides this, Steinmann describes a network of dark lines between the pores and surrounding them, which we were able to observe only in a very imperfect manner.

The walls of which the vesicular tissue is made up show, on the contrary, no structure whatever. Steinmann had already observed this fact. We have figured numbers of sections, highly magnified, but there were never any pores observable. The whole wall consists of a compact shelly mass, without a trace of spicules or any other structure.

The only spicules we observed were contained in the rock that surrounds the fossil, and it is probable that they were originally imbedded in the soft parts of the animal. They are all simply fusiform spicules, sometimes curved, and often with a thorny surface. An axial canal can be distinctly observed in some cases.

One of the strangest facts in the Indian species is the existence of a kind of tabulæ within the central tube. We shall have occasion to recur to this fact.

The genus has up to the present only been found by Barrois in the carboniferous beds of Sebargas, in Asturia.

In India species belonging to the genus are of very general occurrence and have been described already by Koninck. Among the materials at our disposal we can distinguish four different species, which were all found in the middle Productus-limestone.

1. Amblysiphonella vesiculosa, Koninck, sp., Pl. CXXII, fig. 1.

1863. *Orthoceras vesiculosum*, Koninck: Quart. Journ. Geol. Soc., Lond. Vol. XIX, p. 15.
1863. *Orthoceras rachideum*, Koninck: *ibid.* p. 16.
1863. *Orthoceras rachideum*, Kon. et.
1863. *Orthoceras vesiculosum*, Kon.: Fossiles paléoz. de l'Inde, p. 5.

Already on page 67 of the present work the species here under description has been mentioned, and it was stated there that it probably belonged either to the sponges or to the Foraminifera. Upon a closer examination of the fossil we have now decided on placing it with the former.

Mons. de Koninck's description is rather incomplete and must be replaced by a new one, as the characters of the species are rather complicated.

None of the specimens at our disposal is complete. The largest of these, being but a fragment, has been figured by us, Pl. CXXII, fig. 1. It is damaged at the upper extremity as well as at the lower, but on the latter there are indications that not much is wanting. The specimen consists of about 10 or 11 segments, of rather unequal height, each very shortly cylindrical with slightly convex sides. In general they are rather regularly placed one on the other, but some are somewhat more projecting, others are placed somewhat obliquely, so that the whole specimen becomes a little curved. The height of the segments varies between 6 and 12 mm., but the latter height is the rule. Towards the lower extremity the segments become indistinct, and the whole is transformed into one vesicular mass, becoming at the same time rapidly pointed. With this lower pointed extremity the specimen was either attached to foreign bodies or inserted into mud or sand.

If we make a longitudinal or transverse section through the specimen, we find that the centre is occupied by a large cylindrical tube, whilst each segment forms a circular chamber around it. This structure led Mons. de Koninck to consider the fossil as an Orthoceras, and it must be confessed that the similarity is very great.

The tube is traversed at intervals by calcareous lamellæ, which look somewhat like tabulæ, as found in the tubes of corals; but it is rather doubtful whether in the present case these lamellæ are not of a secondary nature, cracks, caused by the drying up of the mud that once filled the tube, and afterwards infiltrated by carbonate of lime.

The central tube is lined with a rather thick wall, consisting of pieces that correspond to each single segment. The walls that separate the segments from each other are common to two successive segments and somewhat thinner. The outer wall of the segments, and thus the outer wall of the whole specimen, has been entirely lost by weathering.

In most of the chambers an irregular number of vesicles can be distinguished, which are generally attached to one of the walls or to each other; sometimes however, strange to say, they appear to be quite free. Mostly the general matrix occupies also the interior of the vesicles; in some cases, however, they are filled with a sparry matrix. Towards the base of the specimen these vesicles augment in number, and the segments as well as the central tube are more or less obliterated.

The structure of the different parts is characteristic. The thick wall of the central tube is pierced by numerous mostly straight canals, which have a width of 0·5 to 1·5mm. The walls that separate the segments from each other are also frequently perforated, and the canals are generally 1·3mm. in diameter. The walls of the vesicles, on the contrary, are nearly always without pores, but rarely here also porous walls can be observed.

Under the microscope the walls appear always of a sparry nature and a minute sxtucture cannot be observed.

In the rock, however, that fills the chambers, spiculæ, as well as the shells of *foraminifera*, are found. The spiculæ are fusiform or curved, always simple, sometimes with an axial canal.

The measurements of the largest specimen are as follow :—

Entire length of the specimen	110	mm.
Breadth at the upper extremity	38	,,
,, ,, lower ,,	32	,,
Average height of the chambers	9	,,
Width of the central tube	10-13	,,

Locality and geological position.—The present species is restricted to the middle Productus-limestone, and has been found at the following localities :—At Khura in the grey limestones forming there the upper region of the middle division (2 sp.) ; and at Bilot in the compact marbly silicious limestones composing chiefly the middle region of the same division. From the same beds came apparently the specimens contained in the Geological Society's collection.

Remarks.—From Mons. de Koninck's descriptions alone it would have been rather difficult to decide what was meant under the names of *Orthoceras vesiculosum* and *rachideum*, and I should not have been able to suggest anything in this direction, had not the Geological Society of London by the liberal loan of the specimens from the Salt-range in its possession given me the opportunity to examine specimens which were labelled in Mons. de Koninck's own handwriting, and which were identical with what is now here described under the name. As the originals from which Mons. de Koninck's description was drawn up have been lost, those specimens in the Geological Society's collection may now be considered as such.

That I unite the two species distinguished by Mons. de Koninck into one, will not appear very surprising, considering the fact that the variation in the outward appearance of the several species is much greater in sponges than it is in *Cephalopoda*, and that thus the same fossils, if considered as the latter, can be easily separated into different species, whilst they have to be taken as forming only one species if considered as sponges. The differences indicated in Mons. de Koninck's descriptions as existing between the two forms cannot be considered as sufficient for the distinction of two different species in this case, and thus we have united them under the name of *Amblysiphonella vesiculosa.*

The most characteristic features of this species are that the specimens occur always simple and seem not to have grown in colonies; that the central tube is very large, and that this is enclosed by shelly parts which are very considerably thicker than the remainder of the shelly coverings occurring in the fossil. Already Mons. de Koninck has remarked this circumstance and mentions it in his description of *Orthoceras rachideum*.

The only European species of *Amblysiphonella* that has been described up to the present is *Ambl. barroisi*, Steinm., from carboniferous beds of Sebargas, in Spain. This species cannot, however, be compared to any of the Indian forms, as on a first glance its comparatively very small size distinguishes it sufficiently. But the structure is also considerably different.

2. AMBLYSIPHONELLA RADICIFERA, Waagen & Wentzel, n. sp., Pl. CXXIII, Pl. CXXIV, fig. 1.

The single individuals are more or less cylindrical and of a considerable length. There are, however, no specimens at our disposal, which are entirely free; all of them are imbedded in a compact limestone and only sections of them are exposed to view. These however are sufficiently instructive to give a complete idea of the whole fossil.

Each individual is built up of single segments, which are on an average 8mm in height and marked off from each other on the outer side of the specimens by shallow furrows. The centre of the individual is occupied by a wide central tube, which is rather irregular in its width, but which, on an average, measures also about 8mm. in diameter. Thus each segment becomes ring-shaped, its wall is fastened by its lower margin to the preceding segment, ascends for a little distance either straightly or curving a little outwards, then bending rather straightly inside and again descending to form the wall of the central tube. The thickness of the walls of the segments is everywhere the same, not more thickened along the central tube, as is the case in the preceding species. Within the hollows of each segment, vesicles of a most irregular and variable shape are developed, which either occur singly or in groups, sometimes filling the entire interior space of a segment and forming thus a regular vesicular tissue.

The structure of the individuals is not the same everywhere. The central tube disappears at a certain distance above the base, the segments become more and more irregular and are at last dissolved into a mass of irregular vesicular cells, composing often root-like appendages, and serving at the same time as a common base to several individuals, spreading out in the most irregular manner. Thus two, three, or four individuals may rise from the same basal mass of cells and diverge in different directions. Irregularities of growth can often be otherwise observed. Sometimes one sees at the upper end of an individual a second smaller tube inserted into the original central tube, which thus attains quite an irregular shape, whilst it is otherwise generally circular.

The intimate structure of the different parts is the same as in other species. The walls of the segments are everywhere pierced by numerous pores, which are 0·2—0·4mm in diameter; the vesicles, on the contrary, have mostly solid walls. In some parts of the best preserved specimen a very singular structure obtains, which has been represented on Pl. CXXIII, fig. 1f. Most of the walls and partitions appear as if double, divided in the middle by a dark stripe. This recalls very much the condition of the walls in the *Monticuliporidæ*, or of the septa in certain asteroid corals. In these latter cases the dark line has been termed "primordial wall" or "primary plate." Whether in the case of the present *Amblysiphonella* this fact has to be interpreted in a similar manner is very difficult to decide, and more observations are necessary to make out whether or not only a singular mode of preservation here obtains.

The species can attain very considerable dimensions and the single individuals may grow to a length of 150 to 200mm.; the specimens at our disposal are, however, too badly preserved to give exact measurements. The general dimensions are exactly represented by our figures.

Locality and geological position.—There were fragments of a large colony, consisting of two individuals springing from the same basal heap of cells, in Dr. Verchère's collection. The entire specimen was not sufficiently well preserved to give figures of it; a portion of it, however, has been figured by us on Pl. CXXIII. The specimen comes from the Trans-Indus continuation of the Salt-range, probably the Rotta Roh, and its rock matter shows unmistakably that it was found in the compact marbly layers of the middle Productus-limestone. Another specimen, composed apparently of only one large basal part or root from which several individuals took their origin, was collected at Virgal in the coal-beds of the middle Productus limestone.

Remarks.—The present species is rather nearly related to *Ambl. vesiculosa* described above. The differences from that species consist chiefly in the basal heap of cells and the root-like appendages it bears, in the altogether more irregular growth, and in the walls, which are throughout of equal thickness in the species here under description.

It cannot be compared to any other form.

3. AMBLYSIPHONELLA MULTILAMELLOSA, Waagen & Wentzel, n. sp., Pl. CXXIV, fig. 2.

It is only a comparatively small fragment that serves for the description and definition of the present species, but this shows such peculiar features that it must be considered as a distinct species.

The fragment consists of two segments, and parts of a third. Each segment is about 10mm. high and 30mm. in its transverse diameter. The fragment is traversed by a very large central tube, terminating at the upper extremity in a large round osculum, which is about 13mm. in diameter. The segments thus become of the shape of rather narrow rings of about equal height and breadth.

On the outer and upper sides of the fragment, the walls of the segments have entirely disappeared by weathering. Only where the segments are in contact with each other and along the inner side of the central tube the walls are preserved. In consequence of the absence of the outer walls, the contents of the segments are exposed to view, and it can be seen that they are crammed with vesicles. The internal structure of the fossil can, however, be better observed if sections are prepared, and we have thus figured several. The central tube appears then partly filled with rock matter, partly with crystals of carbonate of lime. The vesicles are extremely irregular, in shape as well as in size, mostly quite independent of the outer and inner walls of the segments, more or less irregularly globular. They all possess solid walls, without pores. The walls of the segments, on the contrary, are all over perforated, the pores being about 0·2 to 0·3mm. in diameter.

Locality and geological position.—The only specimen of the species available for description was collected by Mr. Wynne in the middle Productus-limestone of Morah. Another fragment, which however only doubtfully can be considered as belonging to this species, comes also from Morah.

Remarks.—The present species is rather nearly related to the two previously described, but yet shows peculiarities which forbid its union with one of these. The most characteristic features of the present form consist in the enormously wide central tube, in the comparatively thin walls that surround it, and the enormous numbers of vesicles by which the interior of the segments is filled. By these peculiarities the present species can be readily distinguished from *Ambl. vesiculosa*, as well as from *Ambl. radicifera.*

From *Ambl. barroisi*, Steinm., it can be immediately distinguished by its much larger size.

4. AMBLYSIPHONELLA SOCIALIS, Waagen & Wentzel, n. sp., Pl. CXXV, fig. 2, Pl. CXXII, fig. 2.

There are only fragmentary specimens of this species at our disposal, but these show very peculiar characters.

The individuals are either single or grown together in pairs for their whole length. On the outer surface the division of the single individuals into separate segments is not distinguishable; they appear more or less smoothly cylindrical, with irregular transverse folds.

In transverse sections or natural fractures, however, the walls separating the segments from each other are often exposed to view, and it can easily be seen that in general the structure of the present species is the same as that of the previously described forms.

Peculiar to the present species are the enormously thick walls, which attain their maximum chiefly in those lining the central tube. Here the wall attains a thickness of 3·5mm., whilst the outer wall and the walls that separate the segments from each other are only 2mm. thick. The enormous development of the wall of the central tube causes the tube itself to become very narrow, and this is another peculiarity of the species, which can be very easily recognised.

As in other species the single segments are here also hollow, and these hollow spaces are partly and irregularly filled with vesicles.

A very strange thing occurring in this species is the union of two individuals for their entire length, being laterally grown together. Where this is the case, the outer wall is common to the two individuals, so that the two can only be distinguished by deep longitudinal furrows, which run along the whole fossil on opposite sides. In transverse sections one sees that in the interiors the two individuals are separated from each other by a separate piece of wall extending from one furrow to the opposite one.

The minute structure of the walls is well distinguishable in sections, as well as on the surface of the fossils. It consists in very numerous pores, larger and smaller, of which, however, apparently only the former ones are the entrances to canals that pierce the whole wall. These have a diameter of 0·2 to 0·3mm. Very much larger are the pores that pierce the thick wall of the central tube; their diameter being from 0·75 to 1mm. The walls of the vesicles are mostly solid, as in other species.

In longitudinal sections there can be observed within the central tube some calcareous lamellæ which look like irregular tabulæ, but of which it is impossible to state whether they are original features, or whether they have been produced by the process of fossilisation.

As only fragments are at our disposal it is somewhat useless to give measurements. As, however, the dimensions are somewhat variable, we shall at least give the transverse measurements.

In the specimen, in which two individuals are grown together, we shall designate the larger individual as I and the smaller as II, whilst the single individual receives the number III.

	I.	II.	III.
Entire transverse diameter	33 mm	29 mm	22 mm
Diameter of the central tube with the wall . .	13 „	12 „	6 „
„ „ „ „ without the wall . .	7 „	4 „	3 „

Locality and geological position.—The larger of the specimens, in which two individuals are grown together laterally, is from the middle Productus-limestone (coral beds) of Virgal, where such specimens seem not to be rare (2 sp.); whilst smaller, single ones, were found at Morah and at Virgal, also in the middle Productus-limestone.

Remarks.—It is very easy to distinguish the present species from all its allies by the very narrow central canal, which is often surrounded by extremely thickened walls.

A character which is not so apparent, but which is also very peculiar, is the existence of comparatively very large canals, which pierce the wall of the central tube. This character approaches the present species to a certain extent to the genus *Sebargasia* of Steinmann. The characters of this genus are, however, still somewhat uncertain. Steinmann distinguishes it from ***Amblysiphonella*** by the presence of somewhat wider canals in the walls of the central tubes, but though this character alone is barely sufficient for the distinction of a genus, yet even this is not made out with certainty, but Steinmann says that apparently such canals are present. Of greater importance seems to us the circumstance that in ***Sebargasia*** the vesicles, which are situated in the interior hollow space of the segments, and are of very general occurrence in ***Amblysiphonella***, are entirely absent. If we take this to be the chief character of the genus, then the species here under consideration must decidedly remain with ***Amblysiphonella*** and cannot be placed into ***Sebargasia***, as here the entire interior space of the segments is occupied by vesicles.

Family: *SPHÆROCŒLIDÆ*, Steinmann.

Steinmann characterises the family in the following manner:—

"It consists of ***Pharetrones***, composed of hollow segments, which are only occasionally filled up in a peculiar manner. A central tube is absent. Walls either solid or perforated. Structure of the walls simple or double. There exists either only one large central osculum, or several smaller ones, or a large central and some smaller ones."

In this definition the indication of the walls being sometimes double has not been confirmed by our own observations. In the Salt-range there are forms very nearly related to ***Sollasia***, Steinmann, which is said to possess double walls. In the Indian forms, however, not a trace of such a double structure can be observed. The irregular distribution of the black layer lining the two lower oscula in Mr. Steinmann's figures of ***Sollasia***, whilst it is absent in the last one, &c., makes it not improbable that this is only a mineral deposit of a secondary origin on the inside of the walls, as we have amply figured similar things in several species of ***Amblysiphonella***, for instance Pl. CXXIV, fig. 2g.

Mr. Steinmann quotes four genera in this family, but none of these is represented in the Salt-range.

The forms represented there belonging to the family compose a new genus, more or less nearly related to ***Sollasia***, perhaps also to ***Sphærocœlia***. We introduce for this genus the name of ***Steinmannia***.

Genus: STEINMANNIA, Waagen and Wentzel, n. gen.

The individuals belonging to this genus are composed of spheroidal segments, which are all arranged in one line forming thus elongated bodies, which are generally not straight but curved in various directions. Each segment is on the outside distinctly marked off from the adjoining ones by deep furrows, so that the whole body takes an appearance like a string of large beads. If the upper surface is preserved, or if a fracture just hits the line of junction between two segments, one sees that each segment is nearly quite closed on the upper side and that only a comparatively small round osculum remains in the centre, by which the chambers formed by the single segments communicate with each other.

The chambers are either entirely or partly filled with vesicles.

The walls are perforated. The pores are of two sizes, smaller and large.

The individuals grow either singly or they are laterally united two or three together for their entire length.

It has been remarked above that the genus is rather nearly related to *Sollasia*, Steinm. Like the present genus, *Sollasia* also consists of a series of spheroidal chambers, in communication with each other by rather narrow oscula, which are in the centre on the top of each chamber. The distinction of two different layers within the substance of the shell, on which character great stress is laid by Dr. Steinmann, does not seem to us of great importance, as it appears rather probable that the inner layer is nothing but a mineral deposit. Nevertheless, there exists a very fundamental difference between *Sollasia* and our *Steinmannia;* as in the former genus rather numerous small ostia are irregularly distributed over each segment, which are entirely absent in the latter. Moreover, the chambers in *Sollasia* are empty whilst they are filled with vesicles in *Steinmannia*. It cannot thus be doubted that the Indian fossil must be considered as forming a different genus.

On the same plate on which *Sollasia* is represented by Dr. Steinmann yet another genus is figured which required some notice. This is *Cryptocœlia*, Steinm. This genus is in so far somewhat similar to our *Steinmannia*, as the more or less hemispherical segments are here filled with a network of somewhat radially arranged meshes, which perhaps might be compared to the vesicles occurring in the interior of the chambers of the Indian forms. The similarity is, however, only a distant one. Whilst in *Steinmannia* the vesicles have generally compact shelly walls, which are in their structure quite different from the general wall of the segments, the walls of the meshes in *Cryptocœlia* are of the same description as the outer wall of the segments, and appear more or less like processes sent out by that wall, causing the entire segments to be filled with a spongy mass. This gives a quite different character to the latter fossil and makes it necessary to place it in an entirely different family from that to which our *Steinmannia* belongs.

The genus is represented in the Salt-range by two species only, of which one occurs in the upper, the other in the middle Productus-limestone.

1. STEINMANNIA SALINARIA, Waagen & Wentzel, n. gen. et sp., Pl. CXXIV, fig. 4, Pl. CXXV, fig. 1 a. b.

The whole body is of a more or less very elongate reversedly conical, or nearly cylindrical shape, never quite straight but always slightly curved. It bears at intervals deep contractions, so that the whole appears subdivided into nearly spheroidal segments, which very slowly increase in size from bottom to top. The lowest segment is the smallest one, and it was probably attached to some foreign body.

The upper end is not known to us; but on a natural fracture that terminates our specimen in that direction, one sees that the last segment preserved almost entirely, is closed at the upper extremity, and pierced only in the centre by a small osculum. It can thus be taken for granted that each segment is similarly provided with such an osculum, and that the actual terminal segment showed an osculum on its upper extremity.

By making a longitudinal section through the specimen one sees, that each segment is closed all round, with the sole exception of the median osculum, forming a spheroidal chamber. Within these chambers vesicles, very irregular in size and shape, are more or less densely distributed, occupying, however, only rarely the entire space.

The outer surface appears ever to the naked eye densely porous. Under a lens one sees that there are two sets of pores, finer and larger, of which the former are by far more numerous. Only the latter are visible to the naked eye.

In sections, the general walls of the segments are seen to be of considerable thickness, 1·5 to 2mm. Only these are distinctly perforated, whilst the walls of the vesicles appear to be compact. Under the microscope the substance of the walls appears finely granular, but spiculæ cannot be distinguished.

It is difficult to give measurements, as only a fragment is at our disposal, in which not more than two segments are intact. The measurements of these are, however, as follow:—

Height of the first (uppermost) segment	15 mm.
Diameter ,, ,, ,, ...	19 ,,
,, ,, ,, segment at lower end	14 ,,
Height of the second segment	12 ,,
Diameter ,, ,, ,, ...	17 ,,
Diameter of the osculum	3 ,,

Locality and geological position.—There is only a single specimen of this species at our disposal. This was collected by Mr. Wynne north of Katwáhi, in the upper Productus-limestone.

Remarks.—The rather scanty materials are barely sufficient to describe the species thoroughly. Chiefly the general shape must remain rather doubtful. If one considers the section Pl. CXXIV, fig. 4*b*., at the upper extremity, an irregularity of growth is observable. To the right there is apparently a small lateral osculum and at both sides of it the commencement of a small hemispherical chamber. If this is really the case, then the species must have been arborescent, and we see here the development of a new branch. The specimen is, however, so fragmentary that one cannot become sure of the matter, though on the whole there is no great improbability that these things were really arborescent.

There is no occasion to compare the present form with any other species, as up to the present, so far as we are aware, nothing has been described that would necessitate a closer comparison.

2. STEINMANNIA GEMINA, Waagen & Wentzel, n. gen. *et* sp., Pl. CXXIV, fig. 3.

The whole fossil is elongated, laterally compressed, composed of numerous spheroidal segments in two rows, which are laterally united and in which each segment is marked off by deep furrows.

We consider the specimen as composed of two individuals, each row of segments representing one; they are laterally grown together in such a manner that the lateral wall of one of the individuals is entirely absent, this part being in common to the two.

The several segments are apparently sometimes in communication with each other by small oscula, which are, however, only rarely observable.

The interior spaces of the segments are either entirely or partly filled up by very irregular vesicles.

As in the preceding species, the walls are densely porous. The species must have attained rather considerable dimensions, but it is very difficult to make out its exact shape and extension, as it is always enclosed in massive, compact limestones, where the shape of the fossils can only be studied in sections. As far as the measurements can at all be taken, they seem to be as follow:—

Average height of the segments	10 mm.
Greatest diameter " "	14 "
Smallest " " "	10 "
Diameter of the oscula (if present)	2 "
Diameter of the two individuals	27 "

Locality and geological position.—The only specimen of this species from the Salt-range is preserved in a piece of compact limestone from Dr. Verchère's collection; it is probably from the Rotta Roh, and evidently came from the middle division of the Productus-limestone.

Remarks.—The materials of the present species are yet by far more inadequate than those of the preceding one, but as this form occurs at certain localities in great numbers, though it be never possible to detach it from the rock, and takes part in the formation of the coral reefs that are met with here and there in the middle Productus-limestone, we thought it not advisable to pass it entirely in silence.

Individuals up to two, three, or perhaps even more, are laterally united, forming thus thick, vertical lamellar expansions, which curve in various directions, and apparently sometimes send off branches. Thus complicated colonies are formed, which can attain considerable dimensions.

From the preceding species, the present one is distinct by the more slender shape of the single individuals and by the remarkable lateral union of several such individuals.

Sub-Kingdom: **PROTOZOA.**

By Dr. Conrad Schwager of Munich.

Class: RHIZOPODA.

Order: FORAMINIFERA.

Family: *NUMMULINIDÆ.*

Sub-Family: *FUSULININÆ.*

Genus: FUSULINA, D'Orb.

Of the names quoted at the head of this paper, only the one belonging to the order requires some remark, in explanation of my having used the name *Foraminifera* of D'Orbigny in preference to others. By other authors the name *Thalamophora* is generally used, but this seems to me a very inadequate one, as it could just as well be employed for *Cephalopoda* with a chambered shell. The same remarks may be applied to the term *Reticularia*, which has also been used by some. Thus, among the names given to the order of old the one introduced by D'Orbigny, when calling it *Foraminifera*, is the least objectionable. But even this one is not in all cases quite appropriate, and I rather feel inclined to propose a new name, *Thalamoprotista*, which more adequately than the others expresses the peculiarities of the order.

As regards the systematic arrangement of the forms more or less nearly related to *Fusulina* proper, it is rather difficult to decide what way of proceeding ought to be adopted. For the present it seems best to follow the arrangement used by H. B. Brady, who characterises the genus *Fusulina* in the following manner:—

"Test fusiform or subglobular, chambers entire, or only subdivided by the infolding of the septal wall, aperture an elongated central fissure."

If the diagnosis is framed so, those forms that have been separated from *Fusulina* under the name of *Schwagerina* do not fall within the scope of it, but must be kept separate. The relation between the two groups is, however, a very close one, and even the infolding of the septal walls occurs in certain species of the last genus at the umbilical ends. Nevertheless, a distinction of the two genera can always be effected without great difficulty, partly by the general aspect exhibited by the different forms of *Schwagerina*, partly, as has been indicated already by Brady, by the existence of true secondary septa. The latter character is, however, not always equally strongly developed, and just the globular forms, which are otherwise the most characteristic ones, show it only in a rather rudimentary state. Even *Schwagerina lepida*, Schw., at the first glance, rather similar to *Fusulina robusta*, Meek, can easily be recognised as belonging to the genus, if both forms be put side by side.

The case is a different one with *Fusulinella*, Möller, another form most nearly related to *Fusulina* proper. According to Möller, this genus is chiefly characterised

Schwager: Carbonische Foraminiferen aus China u. Japan: Richthofen's China, Vol. IV, pp. 109—118.

by the external wall simply bending down to form the septal walls. Brady has taken *Fusulinella* to form nothing but a subgenus of *Fusulina;* but it seems to me that such a position would not quite rightly indicate the real affinities. There are certain forms of *Fusulinella* which in their general habitus can barely be distinguished from *Schwagerina.* At the same time, there exist in some of the species at both sides of the aperture, which are otherwise similar to the aperture of *Fusulina,* thickenings which are extremely similar to those most characteristic for *Schwagerina,* and thus it seems to me more advisable to approach *Fusulinella* to *Schwagerina* rather than to *Fusulina.*

Though we thus arrive at satisfactory results with regard to the distinction of genera, the same can hardly be said with regard to the distinction of species. The question might even be raised in this respect whether different species can be at all distinguished, and, if so, what limits ought to be given to them.

We all agree that in Nature real limits to the single forms do not exist, and that all distinctions we introduce are to a certain extent of a more or less artificial kind. The more we become acquainted with the different forms of organic life, the more we get convinced that all is chained together in the most manifold manner, the links running sometimes parallel, sometimes crossing each other, but always one joining the other. If we now, in such a net-work of chains, want to make distinctions,—and distinctions we *must* make for practical purposes,—this cannot possibly be done without cutting the links to the right and left; that is to say, without ignoring the transitional forms that link our species to those to the right and the left. Thus the species will always be abstractions to a certain extent; but what part of natural science can do without abstractions? Even mathematics, as soon as they are applied to natural objects as in geometry, astronomy, or natural philosophy, cannot do without them. Even these start from the supposition of the equality of things which are not equal in reality. They ignore to a certain extent variations that must occur in nature and arrive at such abstractions just as well as other branches of natural science do. But as, nevertheless, those mathematic disciplines have arrived at such irrevocable results, so we may hope that also biology, if proceeding in the same way, may at last arrive at results, which may be of similar value. Just as the laws, by which nature is governed, have been detected in prosecuting those mathematic disciplines, so the laws which are followed in the development of organisms will at last be unravelled by biology. But long and consequent labour in comparative anatomy, physiology, and palæontology will be needed before those laws can be fixed in so far as to be put into ruling sentences.

I have exposed in one of my former publications my views in this respect, and have tried to show that each species can be considered as forming a mathematic formula, in which the components are the forces which have been at work for the formation of the species. These forces must, however, from the beginning be divided in two different sets, the morphogenetic and the physiological forces, and this distinction is absolutely necessary if we want to arrive at formulæ, which ought to be of any value. The first which find their expression in the characters of the species are of overwhelming importance, whilst the latter are only of secondary value. In the formulæ, which we thus suppose to exist, some of the components appear as variable, others as constant, and the constants will evince more or less considerable resistance if the form of any organic being is attacked, be it by the influence of outward circumstances or other causes.

If, however, the external influences are stronger than the constants existing in the organism, then these must give way. But at the same time the equilibrium of forces which beforehand existed in such an organism is then considerably shaken, a new arrangement must take place, and it not rarely occurs that just one of those characters, which up to then had to be considered as variable, now takes up the place of one of the constants, or that one or all of the former constants are reduced to the rank of variables. In the meantime, before a new state of equilibrium of forces be attained, a species will be subject to manifold variations, whilst the variations will be by far less considerable if equilibrium is again established.

Starting from such considerations, we cannot overestimate the local influences the organisms are subject to, and any system that wishes not only to register the single forms but to treat them in their natural affinities, as well as in their distinctive characters, must take heed of their local relations in time as well as in space. To illustrate this by an example, I may adduce the fact that, if we put—to return directly to the forms here under consideration—the *Fusulinæ*, a species from Russia, at the side of one from North America, join to these again one from China and one of Texas, we may compose in such a way a line of perfect transition from one extreme to the other, but it is very doubtful whether a natural affinity is so established. If, on the contrary, we consider each of the above forms with regard to their local surroundings, each appears as a perfectly separated form, which is most easily recognisable.

I am thus of opinion that the local relations of the single forms must never be neglected in the description and separation of species, and chiefly in forms like the *Fusulinæ*. Where an external sculpture is entirely absent, these local relations are of the utmost importance. The more minutely the distinctions are made in local faunas, without of course ever neglecting also the general affinities, the more safe will be the conclusions we will be able to draw from such minutely described fossils in regard to geological questions, and from this point of view also I have treated the species of the Salt-range.

1. FUSULINA KATTAENSIS, Schwag. n. sp., Pl. CXXVI, figs. 1—11; Pl. CXXVIII, fig. 4.

Shell straightly sub-fusiform, laterally slightly tapering, with twisted and more or less rounded ends. Proportion of the greatest length to the greatest breadth in general 10mm : 2·2mm. Septal plane at both sides spreading out and upraised in the midst; at the base strongly plicated, so that neighbouring folds join tightly together. Chambers narrow in the median part, somewhat bent to the front; in young specimens nearly quite flat, in full-grown ones generally rather vaulted. Sutural lines well marked, in the beginning less so. Average number of chambers in the last volution 25. Embryonal chamber large, globular, or ellipsoidal. Series of altitudes of the volutions 2·22, 2, [1] 7·5, 12, 21, 23, 25. Average increase of the diameters of the shell wall 2, 2 1, 4, 6, 7, 8. Average diameter of the pores in the last whorl 0·12 to 0·16mm. The measured width of the orifice in the last turn is for the most part $\frac{1}{8}$ of the length of the shell.

Locality and geological position.—As type of this species I consider those specimens that come from the upper region of the lower Productus-limestone of Katta, and which have been represented in figs. 1 and 2 of Pl. CXXVI. Specimens from Chidroo, also from the lower Productus-limestone are most probably identical with the typical form. It is not the same with other specimens from Katta which have been found somewhat lower down in the series. These, if more extensive materials were procurable, could, perhaps, be considered as a distinct variety or sub-species, for which the name ***sub-Kattaensis*** might do.

Remarks.—Among all the species of *Fusulina* hitherto described there is none with which the present species could specially be compared, except that perhaps the not yet full-grown more slender specimens have a certain similarity with the typical *Fus. cylindrica* from Miatschkowa. If however one does not use only single select specimens for comparison, but lays the greater stress on the general appearance of the majority of specimens, it will be seen that the great frequency of nearly cylindrical forms is a character which is never to be found among specimens of the Miatschkowa species. A comparison also of the microscopical sections of the present species as drawn by me, with those represented by Möller of ***Fus. cylindrica*** will show directly that there cannot be any doubt about the distinctness of the two species. A third point of importance is the average size, which is very different in the two species.

We have indicated above that at Katta there exist two different layers containing *Fusulinæ*. The specimens from the upper layer we consider as composing the typical ***Fus. Kattaensis,*** whilst the specimens from the lower layer seem to deviate from the typical form to a certain extent. These latter are, however, mostly more or less deformed by pressure, and thus a close comparison is made difficult. The one point, however, can always be ascertained, that both ends are generally more paraboloid in their outline, whilst they are more abbreviated in the typical form. Also the increase of the whorls is a different one.

In mentioning these Katta fossils we must lastly also point out a peculiarity of the pores, which first struck us on these things, but was afterwards also detected on the typical specimens. This peculiarity has been figured, Pl. CXXVI, figs. 10

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[1] These first three numbers indicate always the reciprocal diameters of the walls and the interior space of the embryonal chamber.

and 11, and consists in the fission observable in the external walls of the last chambers of the canals that communicate with the pores, which occurs often with such regularity that one must suppose it to be the normal state. Fig. 10 has been drawn with the utmost care by means of the camera lucida, and there cannot be any doubt about the matter.

2. FUSULINA PAILENSIS, Schwager, n. sp., Pl. CXXVII, figs. 1—7.

Shell elongately fusiform, or transversely elliptic in outline, with blunt and moderately twisted ends. Proportion of the length to the breadth of the shell 13mm. to 1·7mm. Chambers in the middle part of the shell rarely considerably arched, recurved towards the ends, in the beginning nearly flat, the rest but little vaulted. Sutural lines clearly visible on the last whorl, shallow, but sharply defined. Septal plane tolerably enlarged towards the ends. Embryonal chamber remarkably small. Relative proportions of the embryonal chamber and succeeding whorls generally 1·2, 9, 1·2, 3·2, 4·2, 5, 7, 23. The increase of the shell-wall is as follows: 1·2, 1·4, 1·5, 2·2, 3 5, 4·8. Diameter of the pores in the last whorl 0·08mm. Aperture subelliptical, and occupying $\frac{1}{14}$ of the entire length.

Locality and geological position.—This species has, up to the present, been detected only at a single locality, Pail, where it fills the whole rock with millions of specimens. It occurs there towards the upper region of the lower Productus-limestone associated with *Spirifer Marcou*, W.

Remarks.—There are only rock-specimens of a very hard nature in which the present species is enclosed. The whole rock is crowded with specimens, which are in very good preservation, though, on account of the hardness of the surrounding rock-matter, it is mostly only possible to detach the fossils in a quite fragmentary condition from the matrix. Nevertheless, the preservation is so excellent that it was not found difficult to distinguish the present species from the preceding one.

In its general outline and its size the present species shows a certain resemblance to some forms from the upper carboniferous limestone of North America, which are generally quoted under the name of *Fusulina cylindrica.* The form from Missouri seems most similar, though this one is also slightly more slender. With the typical *Fusulina cylindrica* from Miatchkowa in the Moskow basin, there exists only a rather distant similarity. These external similarities might arouse some doubts whether it was quite justifiable to make a new species out of the Indian fossils. These doubts are, however, dissipated as soon as we compare the internal structures of the different forms. In opposition to all the others, the Indian form is characterised by an extraordinarily small embryonal chamber. By this character it can also be easily distinguished from *Fus. Kattaensis* described before. Besides this, there is also the general outline, a different form. Fig. 1*a*, Pl. CXXVII, represents the normal state, the shape which most frequently is met with; whilst fig. 1*c* represents a shape which is of comparatively rare occurrence.

As in all *fusulinæ*, so also in this species the range of variation chiefly finds its expression in the relative length of the shell. On the whole, it seems not very difficult to distinguish the present species from *Fus. Kattaensis*; but according to my view the species cannot as yet be considered as fully established as long as its geological relations to ***Fus. Kattaensis*** on the one hand and ***Fus. longissima*** on the other are not yet quite distinctly made out.

3. FUSULINA LONGISSIMA, Möller, Pl. CXXVII, figs. 7—12; Pl. CXXVIII, figs. 1—3.

1878. *Fusulina longissima*, Möller: Die spiral gewundenen Foraminiferen des russischen Kohlenkalks: Mém. Acad. imp. St. Petersb. VII, Ser. Tome XXV, Nr. 9, p. 59, Pl. I, fig. 4, Pl. II, fig. 1, Pl. VII, fig. 1.

Shell, in the young state, mostly lengthened fusiform; when full-grown nearly cylindrical, often crooked, with rounded sometimes slightly inflated ends. Chambers numerous, unequal; in the beginning almost flat, at last vaulted. In the midst, they are a little arched, coiling at the considerably twisted ends. Size of the septal plane at the lateral ends variable. Mean rate of increase of the whorls 3, 25, 3, 6 5, 11·5, 16, 20·5, 28, 33. Mean rate of increase of the thickness of the chamber-walls, 3, 2·6, 3·2, 5, 6·5, 7·2, 7·8. Aperture in general $\frac{1}{8}$ of the length of the shell. Diameter of the pores in the last whorl 0·12mm.

Locality and geological position.—The typical form of this species has been represented by us on Pl. CXXVII, and the specimens which are there figured all come from the lowest beds of the lower Productus-limestone of the Verala scarp. Together with the typical form, specimens also occur in the same locality which are more tapering towards the ends, or others which more resemble fig. 1 on Pl. CXXVIII. The originals, which are represented on this latter plate, are taken from a red sandstone, collected by Mr. Wynne at Omarkheyl, and which beyond doubt forms there also part of the lower Productus-limestone. Further specimens have been procured from the lower Productus-limestone of the Nila, Wan, and Pail.

Of all the species of *Fusulina* occurring in the Salt-range this one holds the lowest geological position, occurring in the first fossiliferous beds above the lavender clays of the speckled sandstone (Wynne), or even yet followed by a certain thickness of these clays.

Remarks.—Though the present form shows some slight differences from the typical Russian specimens found at the Shiguli mountains, &c., yet these seem to us not sufficiently large to warrant a specific distinction between the two forms. The chief character, which is, however, well developed in the full-grown state, only consists in the very great length of the shell in comparison to its breadth, and this character is most distinctly exhibited by many of the Indian specimens. Nevertheless it cannot be denied there are also other specimens which show a less strong elongation, though also in these the specific character can always be recognised.

The various curving of the shell, a character peculiar to the Indian specimens, gives to these bodies somewhat the appearance of a caterpillar; and if in time, perhaps, a specific distinction of the Indian form should be necessary, the name of *Fus. erucaria* would be a very appropriate one. Among the Indian specimens, the range of variation chiefly finds expression in the conformation of the lateral ends, which are sometimes paraboloid, sometimes more shortly rounded. Size and general appearance are, however, always approximately the same.

By far more difficult is the distinction of the not yet full-grown specimens, as a considerable proportion of these approaches *Fus. Pailensis* rather nearly. From the outward appearance, a distinction would be nearly impossible; but the inner structure of the two species is entirely different. Notwithstanding the great variability of the internal characters of *Fus. longissima*, which has been noticed already by Möller, there is one character which constantly holds good; this is the size of the embryonal chamber. This latter organ is always considerably larger in *Fus. longissima* than it is in *Fus. Pailensis*, and thus there is no difficulty in distinguishing them. Another fact is that *Fus. longissima* grows to a much more considerable size than is ever the case with *Fus. Pailensis;* and, as in the *Fusulinæ*, the size is of great importance for the distinction of species; this character must be considered as an important one.

Among the Indian materials there are specimens which reach quite extraordinary dimensions. There is a specimen from Omarkheyl in which the proportion of the longitudinal to the transverse diameter is 16mm., 2·2mm; another specimen from Verala scarp shows the proportion 12mm., 2·4mm. The transverse diameter of 3mm. exhibited by the specimen represented fig. 9, Pl. CXXVII, suggests even yet larger dimensions. These are considerably larger sizes than have been observed by Möller, whose largest specimen showed the proportions of 11mm., 2·5mm.

4. FUSULINA, sp., indet., Pl. CXXVIII, fig. 5*a*. *b*.

With even greater right than the preceding one, the present form should perhaps bear the name of *Fus. longissima;* but the materials at hand were too scanty to decide the question. As far as the characters of the present form can be made out, they seem to be the following: shell long, nearly cylindrical, straight, with tolerably twisted and shortly rounded ends. Average dimensions probably 9mm., 1·2mm. Chambers nearly straight up to very near the ends; the folds of neighbouring chambers fused together. The average number of chambers in one volution is probably 15.

Locality and geological position.—The few specimens procured of this species were collected at Bhal in beds very low down in the lower Productus-limestone series.

Remarks.—In general appearance, the present form is very near the preceding one; it can, however, be distinguished by its greater slenderness and the straightness of its shell, which is very marked in comparison with the curvature of *Fus. longissima*.

Sub-genus: FUSULINELLA, Möller.

This group is, as has been already remarked in the introduction, very well characterised by the circumstance that the outer wall passes uninterruptedly into the septal walls. At the same time, the present sub-genus possesses the greatest vertical distribution among the forms belonging to the family *Fusulinidæ*. The range of variation of form within the genus is also rather great.

1. Fusulinella Waageni, Schwager, n. sp., Pl. CXXVIII, figs. 10*a*—*c*.

Though but a single specimen of this species was discriminated by my investigations, it is nevertheless so singularly well preserved that I can venture to found the distinction of a proper species on this single individual. As far as the characters could be observed by me, they might serve for the drawing up of the following diagnosis.

Shell lenticular in general out-line, with rounded margins and subconical lateral faces. Chambers but little vaulted, only the final ones more strongly arched. Centre of the disc as well as the septal lines covered by an umbilical callosity. Orifice unknown. The specimen measures from margin to margin (longitudinal diameter) 0·9mm., and from one lateral face to the other (transverse diameter) 0·44mm.

Locality and geological position.—The specimen was procured by me from some chips that were taken by Dr. Waagen off a specimen of *Prod. Indicus*, collected by Mr. Wynne at Khoond Ghât in the middle region of the upper Productus-limestone.

Remarks.—The present species shows a very close affinity to *Fusulinella Struvi*, M., a well-known species of the lower carboniferous beds of Russia. This affinity is a remarkable one, the Indian form being of so very much more recent geological age. But though such an affinity exists, a distinction between the two forms is not difficult. The chief distinctive character is the absence of a depression along the margins, which is so strongly marked in *Fus. Struvi*, without speaking of the umbilical callosity and the callous covering of the septa, which give *Fus. Waageni* form a characteristic appearance.

Family: *LAGENIDÆ*.

Sub-Family: *NODOSARINÆ*.

Genus: LINGULINA, D'Orb.

It is not without interest to meet with a representative of the present group of *Foraminifera* in the Indian beds, though in the *Bellerophon* beds of the Southern Alps several similar forms have been already observed, yet it is not before the Lias that the chief development of the genus takes place; whilst only later on a strict difference between the *Frondicularinæ* and the *Lingulinæ* is developed. The presence of a species of *Lingulina* in the India palæozoic strata is so much the more remarkable as typical forms of *Nodosarinæ* do not generally make their appearance before Permian times.

1. Lingulina decipiens, Schwager, n. sp., Pl. CXXVIII, figs. 11*a*—*d*.

Shell, viewed laterally, broadly wedge-shaped; with a more or less strongly prominent rounded crest along the middle, from which the shell descends slightly and evenly towards the margins. The lateral contours, caused by a slight protruding of the chambers are provided with wavy indentations. The upper termination probably forms a kind of parallelogram with rounded corners and sides. The chambers are tolerably broad; in the beginning nearly flat, later on somewhat vaulted; in the middle but little elevated, the last ones even somewhat depressed. Laterally the chambers bend considerably downward. The sutures are in the beginning barely perceptible, but later on become strongly defined.

The measurements are as follow:—

Greatest length	0·032mm.
„ breadth	0·031mm.
„ thickness	0·006mm.

The shell is pierced by large rather closely arranged pores. The orifice was not visible on any of the specimens at our disposal.

Locality and geological position.—The specimens were detected by me in some fragments of rock that came from the upper Productus-limestone of Khoond Ghât.

Remarks.—The name *L. decipiens* has been employed for this species on account of the circumstance that the general outline, as is shown by the drawings, if alone taken into consideration, would easily cause an observer to consider it as a *Textularia*. As soon as the internal structure, however, is known, its position with *Lingulina* cannot be subject to any doubt. The upper termination, as it has been drawn on the plate, has not been directly observed, but has been restored according to analogy.

On account of the range of variation within the species it is not possible to say much, as only few individuals are at my disposal. So much, however, might perhaps be said that the proportion of the length to the breadth is somewhat, though not very, variable. In the height of the chambers slight differences are also observable.

Family: *LITUOLIDÆ.*

Sub-Family: *ENDOTHYRINÆ.*

Genus: INVOLUTINA Terquem.

This genus also is not generally met with earlier than the Lias. So much the more interesting is it to find a species of the genus here in palæozoic strata.

Its preservation is not quite excellent, but always sufficiently so for recognition of the genus with certainty: hence we have thought it worthy of description.

1. INVOLUTINA CARBONICA, Schwager, n. sp., Pl. CXXVIII, figs. 7—9.

If I give a special name to the specimens here under consideration, it is chiefly on account of their geological position, because otherwise these bodies are barely distinguishable from *Involutina liassica*, Terg. What makes the distinctness chiefly probable is the absence of similar forms in the intermediate formations.

Locality and geological position.—The specimens of this species were procured by me from some fragments of rock that adhered to a specimen of *Bellerophon*, collected by Mr. Wynne in the upper Productus-limestone of Khoond Ghât.

Genus: MARGARITINA, Schwager, n. gen.

We let this new genus follow here without asserting either that it belongs to the *Foraminifera* or even to the *Protozoa;* but as these forms had been united by former describers with those groups, the materials were sent to me, and now I am obliged to give a description.

The present form has been always compared to *Saccamina carteri* from lower carboniferous beds, and it can barely be denied that there exist very near relations to that fossil form, at least in outward appearance. The genus *Saccamina* has lately been excellently described from recent specimens and figured by Brady in his admirable description of the *Foraminifera* collected by the Challenger-expedition. That learned author has, however, already expressed the opinion that the Indian fossils were something very far different from the recent genus, and I perfectly concur with him in this respect. My minute investigations of the Indian materials have brought to light many facts pointing in this direction; but, at the same time, the very near analogies with *Saccamina*, which nevertheless exist, are very remarkable.

As far as I could make out the characters, they can be comprised in the following diagnosis:—

Shell consisting of more or less fusiform or barrel-shaped pieces, which, chiefly in the young state, are ranged one behind the other, like a string of beads, assuming such an appearance, very much like the shell of a *Nodosaria*. In the full-grown state the single pieces are mostly separate. Each of them is provided with two orifices, which are situated at the opposite ends in the longer axis. The substance of the shell is pierced by more or less regularly arranged pores. In a normal state the shell seems to be made up entirely of calcareous matter; but this does not prevent that—exceptionally perhaps in some forms—also foreign bodies should be made use of for the completion of the shell, and thus be embodied in the shell substance. The thickness of the shell is comparatively moderate; but it must be remarked that it is somewhat unequal, which would indicate the existence of some ruggedness or unevenness on the interior shell-surface. Whether any kind of hard tissues partly filled the interior space of the fossil cannot for the present be decided; but we shall see in the description of the species that such a thing is not improbable.

1. MARGARITINA SCHWAGERI, Zittel, sp., Pl. CXXVIII, figs. 12—15.

1876. *Saccamina Schwageri*, Zittel: Hand b. d. Palæontologie I. 1. p. 76, fig. 8 Nr. 5.

There were, on the whole, only single examples of the fossil at disposal for description; only in a single case, in preparing a slide for microscopic inspection, was it observed that several such pieces, gradually diminishing in size, were strung together, forming a body very much like the shell of a *Nodosaria*. The single pieces that otherwise generally occur are either thickly fusiform or sometimes also somewhat more elongated; rarely they are barrel-shaped. The two largest diameters of these pieces show on an average the proportion of 7·5mm., 5mm. There are, however, also specimens, which measure 8·5mm. in height and 9·5mm. in breadth.

Very characteristic of these bodies is the relief with which the outer surface of the shell is covered. It consists of generally six, rarely five sided pits, separated from each other by little edged ridges, and bearing in the middle a small pore (compare fig. 13 f). The diameter of these pores may, in young specimens, be as small as 0·025mm.; in full-grown specimens it is generally 0·09mm. Only in the specimen represented in fig. 15, Pl. CXXVIII, which we consider as a separate variety; the diameter of the pores is as much as 0·13mm. That the shelly surroundings of the pores are of a thoroughly calcareous nature, and that the centre of the six-sided spaces is really occupied by a pore, can easily be ascertained by treating the specimens with dilute acid, whereby the calcareous shell-substance is dissolved, and the rock-matter by which the pores were filled then shown in relief. In this way it was also possible to ascertain that the pores pierce the shell-substance directly and straightly.

In a specimen that has been figured, Pl. CXXVIII, fig. 13*e*, I found a concave plate closing the orifice. This plate is distinguished from the remainder of the shell by its large pores, the diameter of which is about twice the diameter of the pores of the remainder of the shell. This plate is the immediate continuation of the outer wall of the whole fossil, and the direct union of the two could be observed with all possible distinctness. There remains only some doubt whether towards the centre of this plate the pores have been rightly observed.

By far more problematic are those substances that seem to occupy and partly fill the interior space of the shell. I have tried to represent some of my observations in figs. 13*b*, *c*, and *d*, but must confess that these seem to me barely definitive, and it will be necessary to make new studies on better preserved materials. Just as it has been observed by Brady in his *Saccamina*, so also I found most of the specimens simply filled with rock-matter or with calc-spar. There are, however, other cases, which are not quite so exceptional, in which a calcareous substance fills the whole shell, which on a closer examination manifests itself as of a cystoid nature. In this, however, the walls of the single cysts are only distinguishable by a somewhat darker colour. That this appearance is not accidental is shown by the intimate connection of the walls of the cyst with the outer walls of the shell and chiefly with the plate that closes the orifice. Even yet stranger is the further observation, that in specimens which are somewhat impregnated with oxide of iron, one can, under very high magnifying powers, distinguish within the walls of the cysts something like the spicules of sponges, which seem to be mostly arranged in ring-like groups. If such preparations are treated with dilute acid, the spicules become yet more distinctly visible. In making such observations the circumstance must never be lost sight of, that in the rather unsatisfactory condition in which fossils generally are, parasitic organisms are very easily taken as forming original features of fossil bodies; also that in *Margaritina* such parasitic organisms exist. This is beyond doubt in some cases, but with regard to the facts expounded above, such an explanation seems barely admissible, as the great regularity with which the spicules have been observed to occur in several specimens, and the distinctness with which they are arranged and distributed make it highly probable that we have to deal here with original features of these organisms. A further affirmation of this view is obtained by the study of the specimen represented in fig. 14, in which the interior of one of the pieces is exposed to view by weathering and in which a singular structure is observable, on the whole not in contradiction to what has been observed by me in thin sections. To follow the matter further is impossible for the present. We must await the inspection of better materials, which are more strongly impregnated with oxide of iron, before all these questions can be finally decided. In the meantime, the structure, as it has been described by me, appears at least so far deviating from the type of the *Foraminifera*, that the position of the genus *Margaritina* even among the *Protozoa* must be strongly doubted.

Locality and geological position.—The species is not at all rare in the upper division of the Productus-limestone. The greatest number of well-preserved specimens has been collected by Dr. Waagen in the top beds of the upper Productus-limestone of Virgal and Chidru. A piece of rock, containing numbers of specimens of this species, were brought by Mr. Wynne from Khoond Ghât out of the lower beds of the upper Productus-limestone. The geologically oldest specimen was found by Dr. Waagen in the Lower Productus-limestone of Katta. This specimen, however, shows several peculiarities, chiefly exceptionally large pores, and I therefore consider it as constituting a different variety.

Remarks.—If the present species, as has been stated above, does not belong to the *Protozoa*, the question arises, where else ought it to be placed; but this question is much more easily raised than answered. The occurrence of spicules in the interior tissues of the fossil seems to point in the direction of the sponges; but before we can be sure in this respect, yet many other facts ought to be ascertained. On the whole, the greatest analogy seems for the moment to be with the *Pharetrones*, Sub-order *Sphinctozoa*, with which these fossils may, perhaps, be placed in a provisional way.

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  præcox, Waag., n. sp., 243.
  sub-elegans, Waag., n. sp., 246.
Mytilus, Linn., 271.
  patriarchalis, Waag., n. sp., 272.

Naticopsis, M'Coy, 99.
  indica, Waag., n. sp., 101.
  khurensis, Waag., n. sp., 100.
Nautilus, Linn., 42, 85.
  connecteus, Waag., n. sp., 60.
  convolutus, Waag., n. sp., 62.
  flemingianus, Koninck, 48.
  goliathus, Waag., n. sp., 50, 85.
  latissimus, Waag., n. sp., 56.
  multituberculatus, Waag., n. sp., 51.
  ophioneus, Waag., n. sp., 58.
  peregrinus, Waag., n. sp., 47.
  transitorius, Waag., n. sp., 53.
  wynnei, Waag., n. sp., 55.
Neobolus, Waag., n. gen., 756.
  warthi, Waag., n. gen. et sp., 758.
  wynnei, Waag., n. gen. et sp., 759.
Neritomopsis, Waag., n. gen., 106.
  minuta, Waag., n. gen. et sp., 107.
  ovulum, Waag., n. gen. et sp., 108.
Notothyris, Waag., n. gen., 375.
  djoulfensis, Abich., sp., 379.
  inflata, Waag., n. gen. et sp., 384.
  lenticularis, Waag., n. gen. et sp., 385.
  minuta, Waag., n. gen. et sp., 386.
  multiplicata, Waag., n. gen. et sp., 388.
  simplex, Waag., n. gen. et sp., 389.
  subvesicularis, Davidson, sp., 378.
  warthi, n. gen. et sp., 382.
Nucula, Lamk., 250.
  trivialis, Eichwald, 253.
  ventricosa, Hall, 251.
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Oldhamina, Waag., n. gen., 403.
  decipiens, Koninck, sp., 406.
Orbipora, (Eichwald), Dybowsky, 877.
  ambiensis, Waag. & Wentzel, n. sp., 878.
Orthis, Dalm, 563.
  corallina, Waag., n. sp., 572.
  derbyi, Waag., n. sp., 565.
  incisiva, Waag., n. sp., 574.
  indica, Waag., n. sp., 568.
  januceps, Waag., n. sp., 570.
  marmorea, Waag., n. sp., 566.
  pecosii, Marcou, 573.
Orthoceras, Breyn, 66.
  cyclophorum, Waag., n. sp., 68.
  oblique-annulatum, Waag., n. sp., 69.
  punjabiense, Waag., n. sp., 71.
  sp. indet., 72.
Orthothetes, Fischer v. Waldheim, 607.
  semiplanus, Waag., n. sp., 608.
Oxytoma, Meek, 286.
  atavum, Waag., n. sp., 287.

Pachypora, Lindström, 844.
  curvata, Waag. & Wentzel, n. sp., 846.
  jabiensis, Waag. & Wentzel, n. sp., 847.
Palanatina, Hall, 198.
  indica, Waag., n. sp., 200.
Pecten, Klein, 317.
  flemingianus, Koninck, 325.
  præcox, Waag., n. sp., 318.
  prototextorius, Waag., n. sp., 321.
  sub-granosus, Waag., n. sp., 323.
  wynnei, Waag., n sp., 320.
Petalorhynchus, Agassiz, 17.
  indicus, Waag., n. sp., 17.
Phasianella, Lamk., 109.
  arenicola, Waag., n. sp., 109.
Philocrinus, Koninck, 832.
  cometa, Koninck, 833.
Phyllopora, King, 796.
  cribellum, Koninck, 798.
  haimeana, Koninck, 799.
  jabiensis, Waag. & Pichl., n. sp., 797.
Platystoma, Conrad, 103.
  indicum, Waag., n. sp., 105.
Pleurophorus, King, 214.
  acuteplicatus, Waag., n. sp., 223.
  complanatus, Waag., n. sp., 220.
  imbricatus, Koninck, sp., 217.
  sub-ovalis, Waag., n. sp., 219.
Pleurotomaria, Defr., 113.
  durga, Waag , n. sp., 119.
  kattaensis, Waag., n. sp., 121.
  punjabica, Waag., n. sp., 115.
  sequens, Waag., n. sp., 118.
Pœcilodus, Agassiz, 11.
  paradoxus, Waag., n. sp., 12.
Polypora, M'Coy, 781.
  biarmica, Keyserling, 791.
  gigantea, Waag. & Pichl., n. sp., 786.
  koninckiana, Waag. & Pichl., n. sp., 783.
  megastoma, Koninck, sp., 785.
  ornata, Waag & Pichl., n. sp., 788.
  sykesi, Koninck, sp., 789.
  transiens, Waag & Pichl., n. sp., 795.
  vermicularis, Waag & Pichl., n. sp., 793.
Poteriocrinus, Mill., 830.
  sp. indet , 831.
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  aratus, Waag., n. sp., 684.
  asperulus, Waag., n. sp., 693.
  bhalensis, Waag., n. sp., 704.
  compressus, Waag , n. sp., 710.
  cora, Orbigny, 677.
  cylindricus, Waag., n. sp., 702.

Productus—*continued.*
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humboldti, Orbigny, 695.
indicus, Waag., n. sp., 687.
lineatus, Waag., n. sp., 673.
mytiloides, Waag., n. sp., 711.
opuntia, Waag., n. sp., 707.
pardoni, Davidson, 705.
semireticulatus, Mart., 679.
serialis, Waag., n. sp., 700.
spiralis, Waag., n. sp., 681.
subcostatus, Waag., n. sp., 685.
tumidus, Waag., n. sp., 708.
vishnu, Waag., n. sp., 690.
Psammodus, Agassiz, 16.
sp. indet., 16.
Psephodus, Agassiz, 73.
depressus, Waag., n. sp., 75.
indicus, Waag., n. sp., 73.
Pseudomonotis, Beyrich, 276.
deplanata, Waag., n. sp., 285.
garforthensis, King, sp., 278.
gigantea, Waag., n. sp., 283.
inversa, Waag., n. sp., 284.
kazanensis, Vern., 281.
radialis, Phillips, sp., 280.

Reticularia, M'Coy, 538.
elegantula, Waag., n. sp., 545.
indica, Waag., n. sp., 542.
lineata, Mart., sp., 540.
Rhombopora, Meek, 963.
obliqua, Waag., n. sp., 964.
polyporata, Waag., n. sp., 965.
Rhynchonella, Fischer v. Waldheim, 430.
morahensis, Waag., n. sp., 433.
sp. indet., 434.
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Richthofenia, Kayser, 733.
lawrenciana, Koninck, sp., 736.
sinensis, Waag., 742.

Sageceras, Mojsisovics, 37. 81.
bauerianum, Koninck, 39.
primas, Waag., 39.
wynnei, Waag., n. sp., 81.
Schizodus, King, 230.
compressus, Waag., n. sp., 240.
dubiiformis, Waag., n. sp., 238.
pinguis, Waag., n. sp., 236.
rotundatus, Brown, sp., 233.
Schizophoria, Waag., n. gen., 752.
rugosa, Waag., n. gen. et sp., 753.
Septifer, Recluz, 261.
squama, Waag., n. sp., 262.
Serpulites, Murchison, 816.
indicus, Waag., n. sp., 817.
Siomodus, Waag., 9.
dubius, Waag., n. sp., 10.
Spengleria, Tryon, 185.
vetusta, Waag., n. sp., 187.
Sphæriola, Stoliczka, 201.
grandæva, Waag., n. sp., 202.
Spirifer, Sowerby, 507.
alatus, Schloth., sp., 519.
ambiensis, Waag., n. sp., 515.
marcoui, Waag., n. sp., 510.
musakheylensis, Davidson, 512.
niger, Waag., n. sp., 522.
oldhamianus, Waag., n. sp., 518.
striatus, Martin, sp., 509.
wynnei, Waag., n. sp., 517.
Spiriferina, Orb., 498.
cristata, Schloth, 499.
multiplicata, Sow., sp., 502.
nasuta, Waag., n. sp., 504.

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ornata, Waag., n. sp., 504.
vercherei, Waag., n. sp., 506.
Spirigerella, Waag., n. gen., 450.
alata, Waag., n. gen. et sp., 470.
derbyi, Waag., n. gen. et sp., 453.
" " var. acuteplicata, 456.
fusiformis, Waag., n. gen. et sp., 467.
grandis, (Davidson), Waag., 461.
hybrida, Waag., n. gen., et sp., 459.
media, Waag., n. gen. et sp., 465.
minuta, Waag., n. gen. et sp., 460.
numismalis, Waag., n. gen. et sp., 469.
ovoidalis, Waag., n. gen. et sp., 466.
prælonga, Waag., n. gen. et sp., 457.
Spirorbis, Daudin, 814.
helix, King, 815.
Stachella, Waag., n. gen., 171.
bifrons, Waag., n. gen. et sp., 173.
semiaurita, Waag., n. gen. et sp., 174.
Steinmannia, Waag. & Wentzel, n. gen., 979.
gemina, Waag. & Wentzel, n. gen. et sp., 982.
salinaria, Waag. & Wentzel, n. gen. et sp., 980.
Stenopora, Lonsdale, 885.
chæteliformis, Waag. & Wentzel, n. sp., 890.
hemisphærica, Waag. & Wentzel, n. sp., 891.
nicholsoni, Waag. & Wentzel, n. sp., 889.
ovata, Lonsdale, 888.
Streptorhynchus, King, 577.
capuloides, Waag., n. sp., 582.
deltoideus, Waag., n. sp., 585.
distortus, Waag., n. sp., 590.
lenticularis, Waag., n. sp., 581.
operculatus, Waag., n. sp., 583.
pectiniformis, Davidson, 587.
pelargonatus, Schloth., sp., 579.
Strophalosia, King, 640.
costata, Waag., n. sp., 655.
excavata, Geinitz, 642.
horrescens, Vern., 643.
indica, Waag., n. sp., 648.
nodosa, Waag., n. sp., ,652.
plicosa, Waag., n. sp., 650.
rarispina, Waag., n. sp., 645.
tenuispina, Waag., n. sp., 654.
Synocladia, King, 801.
virgulacea, Phill., sp., 802.

Terebratuloidea, Waag., n. gen., 413.
davidsoni, Waag., n. gen. et sp., 416.
depressa, Waag., n. gen. et sp., 419.
minor, Waag., n. gen. et sp., 420.
ornata, Waag., n. gen. et sp., 423.
Thamnatacanthus, Waag., n. gen., 78.
blanfordi, Waag., n. gen. et sp., 79.
Thamniscus, King, 807.
dubius, Schloth, sp., 808.
serialis, Waag. & Pichl., n. sp., 810.

Uncinella, Waag., n. gen., 494.
indica, Waag., n. gen. et sp., 495.
Uncinulus, Bayle, 424.
jabiensis, Waag., n. sp., 427.
posterus, Waag., n. sp., 428.
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Warthia, Waag., n. gen., 158.
brevisinuata, Waag., n. gen. et sp., 161
lata, Waag., n. gen. et sp., 162.
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Xenodiscus, Waag., n. gen., 32.
carbonarius, Waag., n. gen. et sp., 35.
plicatus, Waag., n. gen. et sp., 34.
Xystracanthus, Leidy, 18, 76.
giganteus, Waag., n. sp., 76.
gracilis, Waag., n. sp., 19.
major, Waag., n. sp., 19.

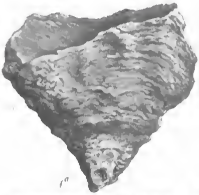
PLATE CXVII.

PRODUCTUS-LIMESTONE.

Figure

1. **Disjectopora milleporæformis**, Waagen and Wentzel, n. gen. et sp., 948. Fragmentary specimen of the hydrophyton from the middle Productus-limestone of Morah :—1*a*, lateral view; 1*b*, view from the base, both natural size; 1*c*, part of the surface not far from the upper extremity, enlarged about 10 times, showing a "rectilinear" structure of the skeleton and apparently parts of a kind of epitheca; 1*d*, part of the surface from near the lower extremity, showing a "curvilinear" structure of the skeleton and two different modes of preservation, enlarged about 10—15 times; 1*e*, part of a vertical section, showing two of the vertical tubes (calices) cut longitudinally and two of the horizontal canals, a tabula is present in one of the vertical tubes, some parts are very strongly altered by the process of fossilisation, enlarged 50 times; 1*f*, part of a horizontal section, enlarged 50 times, in the centre, and towards the upper left-hand corner, the vertical tubes (calices) are cut transversely, in other places obliquely; 1*g*, portion of the strongly altered parts of fig. 1*e*, enlarged 100 times, to show their singular structure.

2. **Carterina pyramidata**, Waagen and Wentzel, n. gen. et sp., p. 945. Fragmentary specimen of the hydrophyton from the middle Productus-limestone of Chidroo :—2*a*, lateral view; 2*b*, view from the base, both natural size. (See also Pls. CXVIII and CXX.)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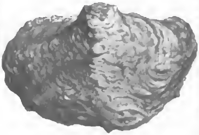
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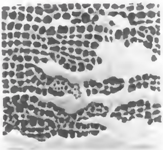
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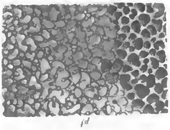
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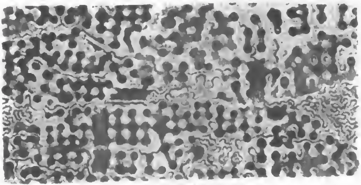
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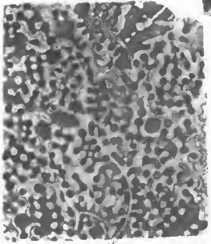
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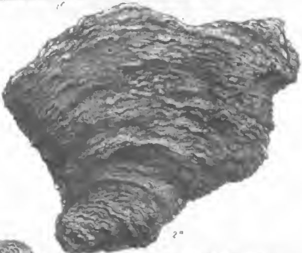
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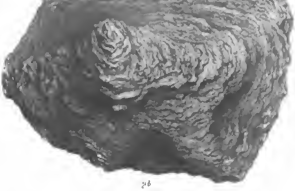
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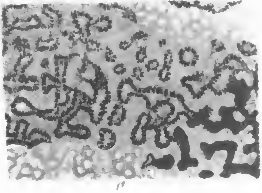
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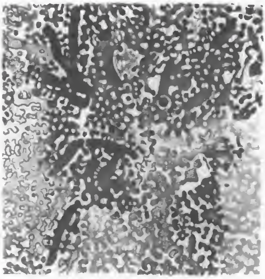
PLATE CXVIII.

PRODUCTUS-LIMESTONE.

Figure 1. **Carterina pyramidata**, Waagen and Wentzel, n. gen. et sp., p. 945. Surface drawings and enlarged microscopical sections of the specimen represented on Pl. CXVII, fig. 2 :—1*a*, part of the fracture that terminates the fragmentary hydrophyton on the upper extremity, enlarged 30 times (reflected light), the star-shaped vertical tubes (calices) are distinctly visible, the radiating canals less so, the large round cavity to the left is probably the work of some boring animal but might be also the cavity of a gonophore as in *Sporadopora*; 1*b*, microscopical horizontal section (transmitted light) enlarged 50 times, none of the vertical tubes (calices) is cut straightly but several are hit obliquely by the section, on the left hand upper corner; the sloping radiating canals are very distinctly visible, preservation very different in different places; 1*c*, microscopical vertical section (transmitted light), enlarged 50 times, vertical tubes distinctly visible; 1*d*, part of the lateral surface of the hydrophyton (reversed, upside down), showing the vertical tubes and lateral radiating canals, enlarged 30 times (reflected light).

2. **Irregulatopora undulata**, Waagen and Wentzel, n. gen. et sp., p. 952. Fragmentary specimen of the hydrophyton from the middle Productus-limestone of Bilote :—2*a*, view of the under surface; 2*b*, lateral view, both natural size; 2*c*, microscopical section parallel to the surface of the hydrophyton, numerous calices and some radiating canals well distinguishable, enlarged 50 times (transmitted light); 2*d*, microscopical section vertical to the surface of the hydrophyton, rather badly preserved; trabecular tabulæ traversing one of the vertical tubes, enlarged 50 times (transmitted light).

1b



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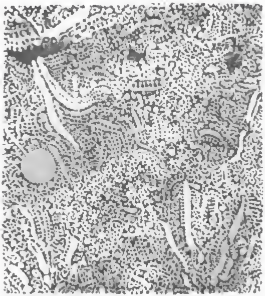

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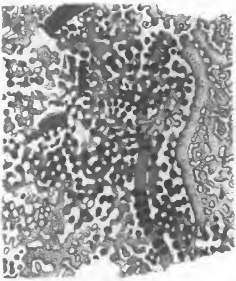

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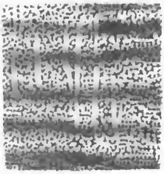

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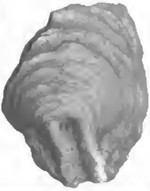

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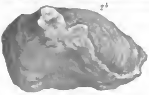

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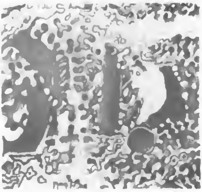

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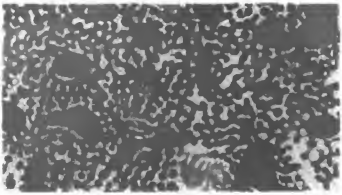

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PLATE CXIX.

PRODUCTUS-LIMESTONE, AND RECENT.

Figure

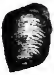
1. CIRCOPORA FAVEOLATA, Waagen and Wentzel, n. gen. et sp., p. 958. Small fragmentary specimen of a hydrophyton with weathered surfaces from the middle Productus-limestone of Morah :—*1a*, lateral view; *1b*, view of the lower extremity, both natural size; *1c*, part of the weathered lateral surface reversed, upside down, showing the concentric lamellæ and vertical pillars, enlarged about 20 times; *1d*, part of the weathered surface of one of the concentric lamellæ, showing the irregularly porous nature of it, enlarged 20 times; *1e*, lower extremity of the specimen, the upper part of the figure showing the surfaces of some of the concentric lamellæ, the lower part represents a very oblique fracture in which lamellæ and pillars are exposed, enlarged 5 times.

2. CIRCOPORA FAVEOLATA, Waagen and Wentzel, n. gen. et sp., p. 958. Microscopical sections of another specimen (represented Pl. CXX, fig. 1) from the middle Productus-limestone of Morah :—*1a*, horizontal section; *1b*, vertical section. Both enlarged 50 times.

3. MILLEPORA NODOSA, Recent. Copies of Mr. Mosley's figures:—*3a*, section parallel to the surface of the hydrophyton, showing some calices cut transversely, and one of the main horizontal canals, the trabeculæ are partly traversed by the tubular cavities of boring organisms; *3b*, part of the surface of the hydrophyton, showing a group of zooid-cavities, of which the larger have served for the reception of a mouthed zooid, whilst the smaller were occupied by mouthless zooids. Both figures strongly enlarged.

4. MILLEPORA, *sp.*, Recent. Copy of Mr. Mosley's figure: section vertical to the surface of the hydrophyton, showing one of the zooid cavities, traversed by tabulæ, and some of the main horizontal canals, strongly enlarged.

1a



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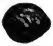

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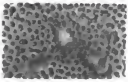

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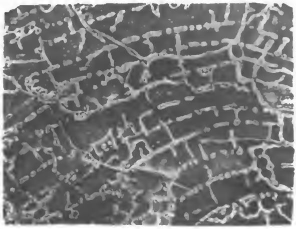

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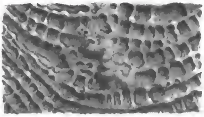

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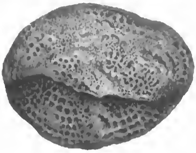

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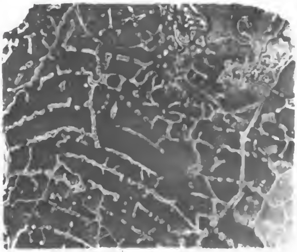

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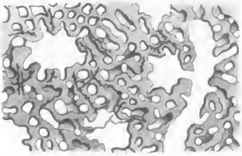

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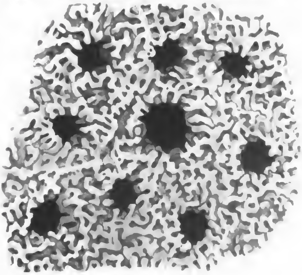

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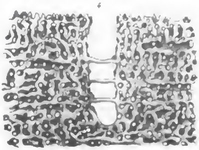

A. Swoboda del. et lith.

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PLATE CXX.

PRODUCTUS-LIMESTONE, AND DEVONIAN OF EUROPE.

Figure

1. CIRCOPORA FAVEOLATA, Waagen and Wentzel, n. gen. et sp., p. 958. Fragmentary specimen from the middle Productus-limestone of Morah:—1*a*, lateral view, weather-worn, reversed, upside down; 1*b*, polished upper surface, both natural size (see also preceding plate, fig. 2).

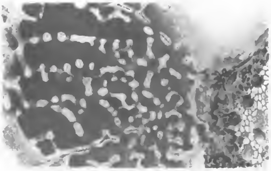
2. CIRCOPORA TUBULOSOSA, Waagen and Wentzel, n. gen. et sp., p. 960. Two microscopical sections of a specimen from the middle Productus-limestone of Morah:—2*a*, section parallel to the longer axis of the specimen (vertical section); 2*b*, section vertical to the longer axis (horizontal section), both enlarged 50 times.

3. CARTERINA PYRAMIDATA: Waagen and Wentzel, n. gen. et sp., p. 945. Microscopical section, cutting one of the vertical tubes (calices) transversely and exposing three of the sloping radial canals, which are traversed by trabecular tabulæ; enlarged 50 times (see also Pls. CXVII and CXVIII).

4. STROMATOPORA (= PACHYSTROMA) CONCENTRICA, Goldf. Microscopical section of a specimen from the middle Devonian limestone of Schmidtheim in the Eifel:—4*a*, horizontal section, extending within the plane of one of the concentric layers of trabeculæ, showing the reticulate structure of the latter, the white spots representing the matrix, enlarged 50 times; 4*b*, part of the same section more strongly enlarged (80 times), to show more distinctly the structural peculiarities of the trabecular mass.

5. STROMATOPORA (= PACHYSTROMA) CONCENTRICA, Goldf. Microscopical section of the same specimen from which fig. 4 is taken:—5*a*, section vertical to the plane of the concentric layers, the figure is not rightly placed, the horizontal layers extending in the direction of the series of black spots, the trabeculæ show again the dark reticulate structure, enlarged 50 times; 5*b*, part of the same section more strongly enlarged, to show more clearly the reticulate structure of the trabeculæ, enlarged 60 times.

2a



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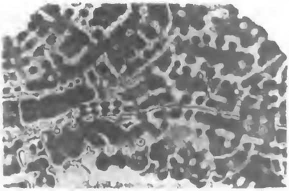

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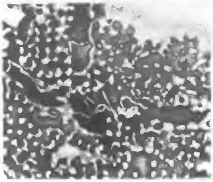

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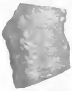

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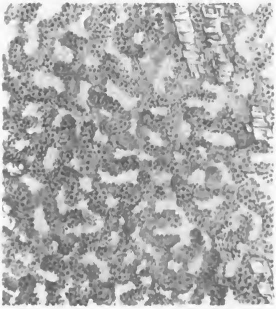

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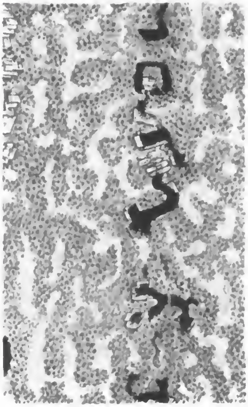

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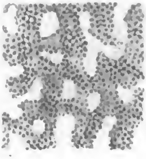

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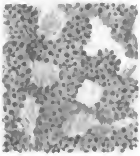


A. Swoboda del et lith. Jos. Hampl [illegible]

PLATE CXXI.

DEVONIAN OF EUROPE, AND RECENT.

Figure

1. **Stromatopora (= Pachystroma) concentrica**, Goldf. Fragmentary specimen from the middle Devonian limestone of Schmidtheim in the Eifel:—1*a*, a cubical fragment in natural size, showing the natural lateral face above and a polished surface in front, the direction of the layers ought to be placed horizontally, the lateral face is plaited, and from the furrows extend dark ferruginous zones into the interior, the spaces between seem to be compact towards the surface the dark zones appear partly as open fissures (all these characters agree with Pachystroma, Nich. & Murie); 1*b*, part of a microscopical horizontal section, showing radially arranged cœnosarcal canals, and representing probably the place where one of the zooids was located, enlarged 50 times; 1*c*, vertical transparent section of the same specimen, the white spots represent the matrix, the dark matter the trabeculæ, the black zones are made up of hydroxide of iron, enlarged 5 times.

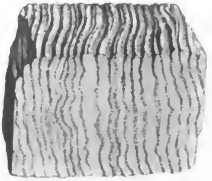
2. **Sporadopora dichotoma**; Recent. Copy of Mr. Mosley's figure. Section through part of the skeleton vertical to the surface. The whole is made up of a porous mass, traversed in all directions by cœnosarcal canals. The tubes sunk into this mass are the dwellings of the zooids. The largest of these, bearing a columella in the middle and showing a tabula is that of a gasterozooid; the smaller ones, without columellæ, are occupied by dactylozooids, and the large round cavity contains a male gonophore in the living state. The figure is much enlarged.

3 **Millepora**, sp. div. Recent. Copies of Mr. Mosley's figures:—3*a*, soft parts of *Millepora nodosa* decalcified by chromic acid and viewed from the undersurface in reflected light, showing a group of zooids the canals of the cœnosarc and the main horizontal canals; 3*b*, vertical section through the soft parts of *Millepora nodosa*, decalcified by chromic acid, showing the cœnosarcal canals the soft outer covering of the whole hydrophyton and one of the mouthed zooids in a retracted state; 3*c*, section parallel to the surface through part of the skeleton of a species of *Millepora* from Zamboangan, the cavities have been filled with opaque matter. All these figures are more or less strongly enlarged.

4. **Millepora**, sp. Recent. Microscopical section through part of the skeleton. A "rectilinear" structure, as in most species of *Stromatopora*, is observable; and at the same time the intimate structure of the trabeculæ is identical with what has been figured in *Stromatopora concentrica* on the preceding plate. Enlarged 60 times.

N.B.—We have taken the liberty of copying a number of Mr. Mosley's admirable figures, contained in the *Philosophical Transactions* of 1877 and 1878, because their comparison is absolutely indispensable for the right understanding of our deductions, and because the greater part of our Indian readers will not have access to Mr. Mosley's original drawings.

1a



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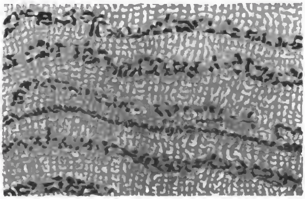

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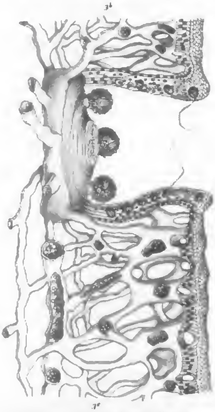

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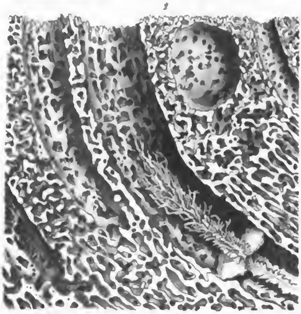

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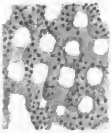

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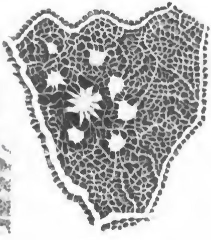

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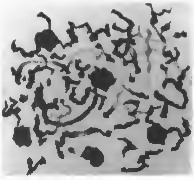

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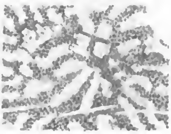


A. Swoboda del. et lith.

Joh. Haupt print.

PLATE CXXII.

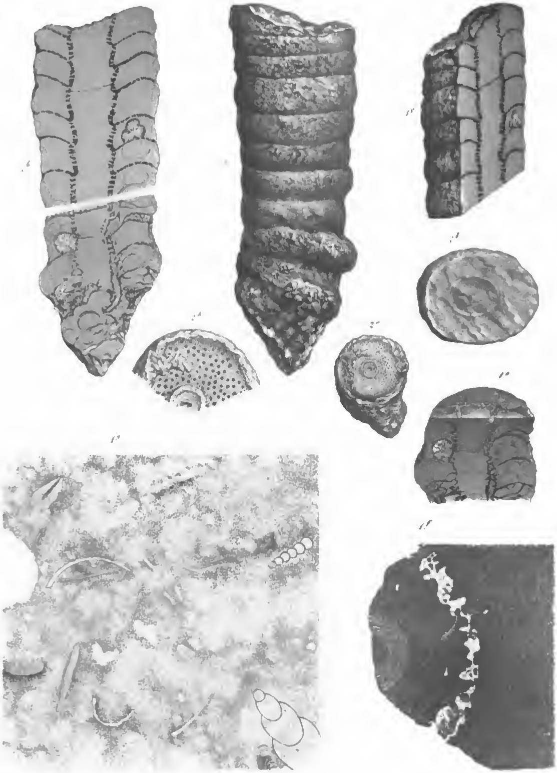
PRODUCTUS-LIMESTONE.

Figure

1. AMBLYSIPHONELLA VESICULOSA, Koninck, sp., p. 973. A tolerably complete specimen from the upper region of the middle Productus-limestone of Khoora :—1*a*, lateral view; 1*b*, longitudinal section; 1*c*, the same, upper part, seen obliquely; 1*d*, upper end (fracture) of the fossil, showing the diameter of the central canal; 1*e*, longitudinal section of the lower part seen obliquely from above—all these figures are natural size; 1*f*, part of the transverse section of the fossil, showing a part of the wall of the central canal, preserved as a white sparry matrix and traversed by many irregular canals and pores, enlarged 5 times; 1*g*, part of the rock-matter filling the chambers enlarged 120 times, showing sections of different Foraminifera and of several spicules straight and curved, of which two show a central canal.

2. AMBLYSIPHONELLA SOCIALIS, Waagen and Wentzel, n. sp., p. 977.—Small single specimen from the middle Productus-limestone of Morah :—2*a*, view from above, showing the upper surface of one of the chambers and the very narrow central canal (the point in the centre is accidental), natural size; 2*b*, part of the same enlarged, to show the pores of two different sizes.

SALT-RANGE FOSSILS.

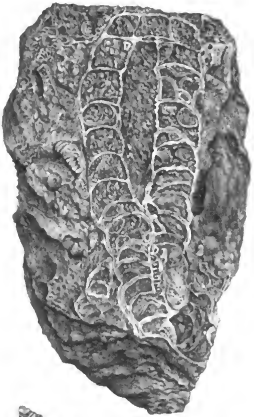


A. Swoboda del. et lith. [illegible]

PLATE CXXIII.

PRODUCTUS-LIMESTONE.

Figure 1. **Amblysiphonella radicifera**, Waagen and Wentzel, n. sp., p. 975. Fragmentary specimen, enclosed in hard rock and visible only in sections; from Dr. Verchère's collection, coming probably from the middle Productus-limestone of the Rotta Roh:—1*a*, longitudinal section, cutting the specimen not quite regularly in the middle line; 1*b*, longitudinal section, vertical to the preceding and representing only one-half of the specimen, the part to the right being the rock that fills the central tube; 1*c*, transversal section at the upper end of the specimen, showing the irregular development of the central tube at this place; 1*d*, transversal section at the base of the specimen, showing the heaps of irregular cells, forming a kind of root; 1*e*, transversal section on about half the height of the specimen, on the upper right-hand corner the wall of the central tube can be distinguished, all these figures are of natural size; 1*f*, two of the chambers of figure 1*a*, enlarged to show the primordial stripe in the middle of some of the elements of the skeleton.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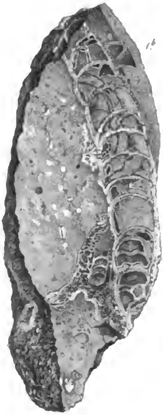
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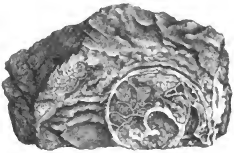
1e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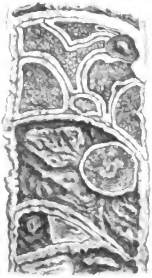

1f

A. Swoboda del. et lith.

Joh. Haupt print.

PLATE CXXIV.

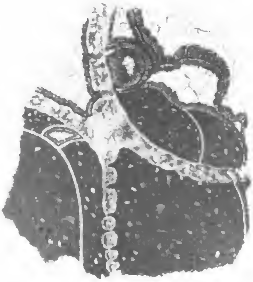
PRODUCTUS-LIMESTONE.

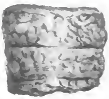
Figure 1. **Amblysiphonella radicifera**, Waagen and Wentzel, n. sp., p. 975.—Microscopical section of a fragment of the specimen represented on Pl. CXXIII, showing the perforated thicker walls of the chambers and the compact walls of the vesicles; enlarged 6 times.

2. **Amblysiphonella multilamellosa**, Waagen and Wentzel, n. sp., p. 976.—Fragmentary specimen from the middle Productus-limestone of Morah :—2*a*, lateral view; 2*b*, longitudinal section; 2*c*, the same seen somewhat obliquely; 2*d*, one-half of the specimen seen from above, showing the very wide central canal—all these figures are natural size; 2 *e*, one-half of the specimen cut longitudinally and transversely and seen somewhat obliquely from below, the dark perforated lines are the cut edges of the thick walls of the chambers; 2 *f*, the same seen from above, these latter two figures are slightly enlarged; 2 *g*, microscopical longitudinal section, showing the perforated chamber-walls and the compact walls of the vesicles, enlarged 9 times.

3. **Steinmannia gemina**, Waagen and Wentzel, n. gen. et sp., p. 982.—Fragmentary specimen, enclosed in hard rock and visible only in sections, from the middle Productus-limestone of Bilote :—3 *a*, longitudinal section; 3 *b*, transversal section, showing the lateral union of two specimens; both figures natural size.

4. **Steinmannia salinaria**, Waagen and Wentzel, n. gen. et sp., p. 980.—Fragmentary specimen from the upper Productus-limestone of north of Katwahee :—4 *a*, lateral view; 4 *b*, longitudinal section; 4 *c*, view of the upper extremity from above—all three figures natural size; 4 *d*, part of the surface showing the differently-sized pores, enlarged 8 times.

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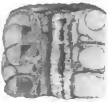
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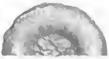
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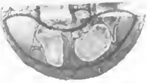

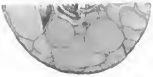
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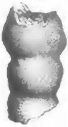
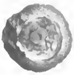
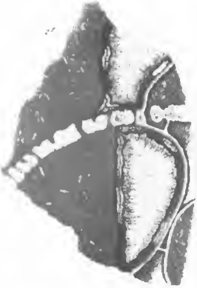
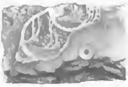
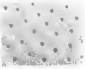










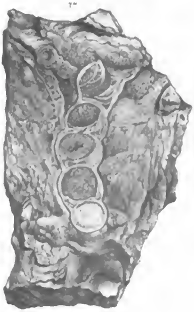


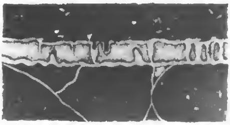
PLATE CXXV.

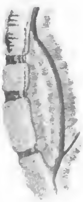
PRODUCTUS-LIMESTONE.

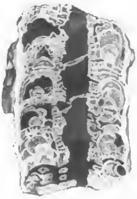
Figure 1. **Steinmannia salinaria**, Waagen and Wentzel, n. gen. et sp., p. 980. Microscopical sections of fragments taken from the specimen figured on the preceding plate :—**1a**, vertical section through the external wall of one of the chambers and one of the vesicles, enlarged 9 times; **1b**, section through the chamber-wall and some vesicles, at the limit of two successive chambers, enlarged 15 times. The granular structure may perhaps arise from the wall being composed of minute spicules, but it is impossible to say anything positive in this direction.

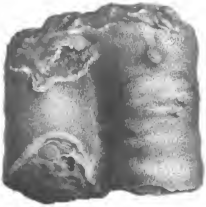
2 & 3. **Amblysiphonella socialis**, Waagen and Wentzel, n. sp., p. 977. Fragmentary twin-specimen from the coral beds of the middle Productus-limestone of Virgal :—*2a*, lateral view; *2b*, view from the upper extremity; *2c*, longitudinal section of one of the individuals; *2d*, transversal section through the one, and half of the second individual—all these figures of natural size; *2e*, part of the surface enlarged 8 times, to show the differently-sized pores; 3, microscopical section through part of the chamber-wall, enlarged 90 times. One sees the canals piercing the wall, corresponding to the pores, and a network of dark lines, composed of hydroxide of iron, perhaps indicating the existence of a network of fine canals.

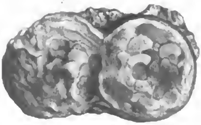
4. **Amblysiphonella**, sp. ind. Microscopical section of a fragment from Morah, which is too badly preserved to be determined specifically, but in which the chamber walls show a singular structure; enlarged 8 times.

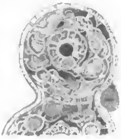


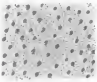


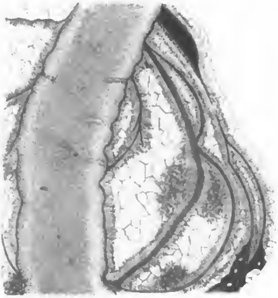












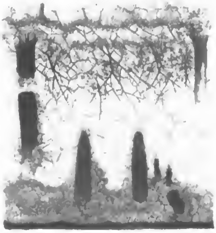


PLATE CXXVI.

PRODUCTUS-LIMESTONE.

Figures 1—5. **FUSULINA KATTAENSIS**, Schwager, n. sp., p. 985. *1a—d*, several specimens, natural size, from the lower Productus-limestone of Katta; 2, another specimen enlarged; 3, longitudinal section, more strongly enlarged to show the embryonal chamber and the mode of increase; 4, transversal section, enlarged; 5, the same still more strongly enlarged to show the nature of the pores.

6—11. **FUSULINA KATTAENSIS**, Schwager var., p. 985.—*6a, b, c*, several specimens from the lower Productus-limestone of Katta (higher beds); *6d*, typical specimen, enlarged; 7, transverse section more strongly enlarged; 8, the same; 9, part of a transverse section yet more strongly enlarged to show the nature and size of the pores; 10, strongly enlarged section of the pores taken from the last whorl of a full-grown specimen, (*a*, section at the base, *b*, at the divided peripheral ends); 11, the same, transverse section of a fragment of the shell.

SALT-RANGE FOSSILS.

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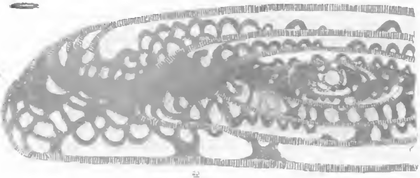
2.

3.



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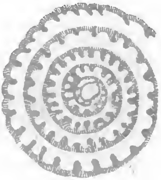

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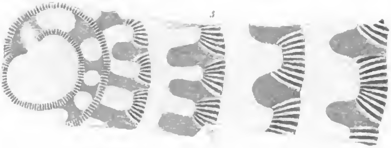

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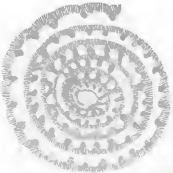

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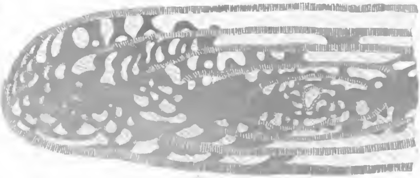

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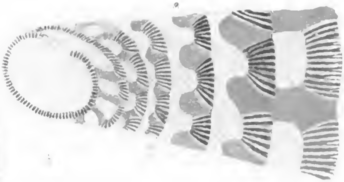

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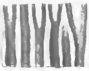

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PLATE CXXVII.

PRODUCTUS-LIMESTONE.

Figures 1—6. **Fusulina pailensis**, Schwager, n. sp., p. 987.—*1a—c*, several specimens from the lower Productus-limestone of Pail, natural size; 2, another specimen enlarged; 3, longitudinal section to show the embryonal chamber and the mode of increase; 4, transversal section; 5, longitudinal section of the embryonal part of the shell, more strongly enlarged; 6, part of the peripheral region of a longitudinal section of a full-grown specimen, more strongly enlarged.

7—12. **Fusulina longissima**, Möller, p. 988.—*7a*, *b*, two specimens from the lower Productus-limestone of Verala scarp, natural size; 8, specimen, enlarged; 9, transverse section, strongly enlarged to show the embryonal chamber and the mode of increase; 10, longitudinal section; 11, embryonal chamber, yet more strongly enlarged; 12, part of the transverse section of the last chambers, enlarged 100 times.

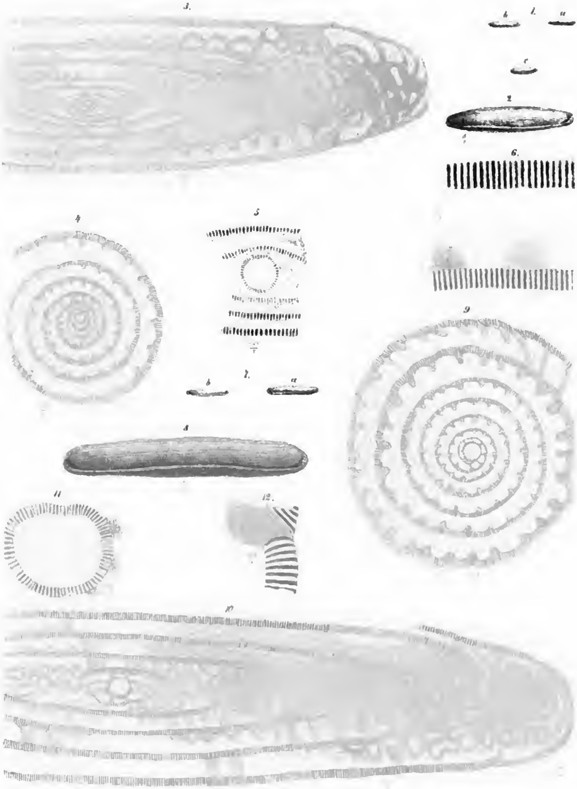

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PLATE CXXVIII.

PRODUCTUS-LIMESTONE.

Figures 1—3. Fusulina longissima, Möller, p. 988.—1, a very characteristic specimen, not quite complete, from the lower Productus-limestone of Omarkheyl, natural size; 2, the same enlarged; 3, very slender specimen from the same locality as the preceding, natural size.

4. Fusulina kattaensis, Schwager, var., p. 985. From the lower Productus-limestone of Katta.

5 & 6. Fusulina, sp., p. 989. From the lower Productus-limestone of Bhal; 5, natural size; 6, one of the specimens enlarged.

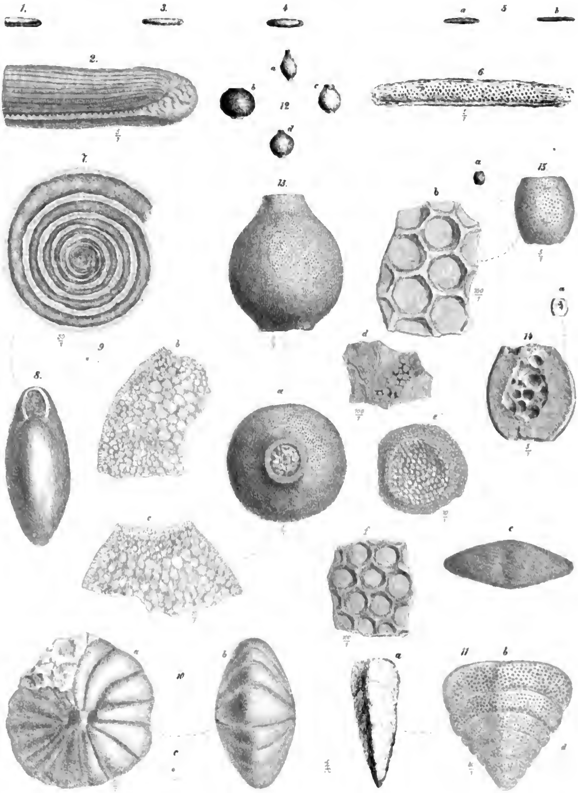
7—9. Involutina carbonica, Schwager, n. sp., p. 992. Specimen from the upper Productus-limestone of Khoond Ghat:—7, transverse section, enlarged; 8, lateral view, somewhat completed; 9, the same, natural size.

10. Fusulinella waageni, Schwager, n. sp., p. 990. Specimen from the upper Productus-limestone of Khoond Ghat:—*a*, lateral view, enlarged; *b*, marginal view; *c*, natural size.

11. Lingulina decipiens, Schwager, n. sp., p. 991. Specimen from the upper Productus-limestone of Khoond Ghat:—*a*, marginal view; *b*, lateral view, both enlarged; *d*, natural size.

12—14. Margaritina schwageri, Zittel, sp., p. 993. From the top beds of the upper Productus-limestone of Virgal:—12*a*—*d*, several specimens, natural size; 13, lateral view, enlarged, (*a*, top view; *b*, radial section from the middle of the lateral part; *c*, from the peripheral part, both strongly enlarged; *d*, part from the interior of the shell, to show the occurrence of spongia-like spicules, very strongly enlarged; *e*, sieve-plate of the axial part below the orifice, but little enlarged; *f*, surface of the shell, very strongly enlarged); 14, a barrel-shaped specimen in which the cavities of the interior of the shell have been exposed to view by weathering, enlarged; 14*a*, natural size.

15. Margaritina schwageri, Zittel. var., p. 993. Specimen from the upper region of the lower Productus-limestone of Katta:—*a*, natural size; *b*, part of the surface strongly enlarged, to show the exceptionally large pores.



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